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News Division OPA

Beltsville Human Nutrition Research Center

1992

United States Department of Agriculture

Agricultural Research Service

Beltsville, Maryland 20705

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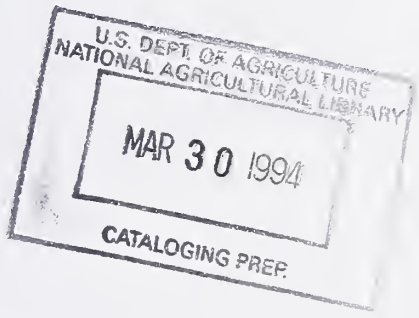

United States Department of Agriculture
Agricultural Research Service
Beltsville Human Nutrition Research Center
Beltsville, Maryland 20705

Mission: To (1) conduct research relevant to human requirements for energy, protein, carbohydrates, lipids, vitamins and minerals and their bioavailability from commonly eaten foods which will assure optimal function throughout the life cycle; (2) develop dietary strategies which can lead to postponement of the onset of nutritionally-related debilitating diseases. In carrying out this twofold mission small laboratory animal models are developed and utilized for determination of design and performance of human studies. Animal studies are used to establish new hypotheses, test existing ones and to clarify basic metabolic function of nutrients. Controlled human dietary-metabolic studies are used as the experimental tests upon which can be developed dietary strategies for a healthy Nation and guidance for improving the nutritional quality of food crops and animals.

Office of Center Director
Beltsville Human Nutrition Research Center
Beltsville, Maryland 20705

Mission: The Office of Center Director provides for coordination, evaluation and safety of all nutritional studies involving human subjects and for the rapid application to human studies of knowledge concerning nutrient bioavailability and interactions, metabolic mechanisms of action and nutrient requirements which were developed through studies using animal models.

Dr. Walter Mertz
Director
Room 223, Building 308
Beltsville, Maryland 20705
301/504-8157

Provides leadership to the Center. Studies health-related problems relating to nutriture of trace elements.

Ms. Priscilla D. Steele
Chief Dietitian
Room 326, Building 308
Beltsville, Maryland 20705
301/504-8411

Provides leadership to the Human Study Facility.

PUBLICATIONS

1989

Mertz, W., Morris, E.R., Smith, J.C., Udomkesmalee, E., Fields, M., Levander, O.A., and Anderson, R.A. Trace Elements in the Elderly. Metabolism, Requirements, and Recommendations for Intakes. In: Nutrition, Aging and the Elderly. (H.N. Munro and D.E. Danford, eds.), Plenum Publ. Co., New York, pp. 195-244, 1989.

Buzina, R., Bates, C.J., van der Beek, J., Brubacher, G., Chandra, R.K., Hallberg, L., Heseker, J., Mertz, W., Pietrzik, K., Pollitt, E., Pradilla, A., Suboticanec, K., Sandstead, H.H., Schalch, W., Spurr, G.B. and Westenhofer, J. Workshop on Functional Significance of Mild-to-Moderate Malnutrition. Am. J. Clin. 50:172-176, 1989.

Mertz, W. Trace Element Requirements and Current Recommendations. In: Current Trends in Trace Element Research (G. Chazot et al., ed.), Smith-Gordon, pp. 1-6, 1989.

Mertz, W. Minerals. In: Nutrition in the Elderly. (A. Horwitz, et al., eds). Oxford University Press, pp. 137-150, 1989.

1990

Mertz, W. The Role of Trace Elements in the Aging Process. In: Nutrition and Aging. (D.M. Prinsley and H.H. Sandstead, eds.). Alan R. Liss, New York, pp. 229-240, 1990.

1991

Mertz, W. General Considerations Regarding Requirements and Toxicity of Trace Elements. In: Trace Elements in Nutrition of Children-II. Nestle Nutrition Workship Series, Volume 23 (R. K. Chandra, ed.). Raven Press, New York, pp. 1-13, 1991.

Mertz, W., Tsui, J. C., Judd, J. J., Reiser, S., Hallfrisch, J., Morris, E. R., Steele, P. D. and Lashley, E. What are people really eating? The relation between energy intake derived from estimated diet records and intake determined to maintain body weight. Am. J. Clin. Nutr. 54:291-295, 1991.

Mertz, W. Trace Elements in Aging. In: Nutrition of the Elderly. Nestle Nutrition Workshop Series, Vol. 29, (H. Munro and G. Schlierf, eds.). Vevey/Raven Press, Ltd., New York, pp. 145-149, 1992.

Mertz, W. Chromium History and Nutritional Importance. Biological Trace Element Research 32:3-8, 1992.

Mertz, W. The Reevaluation of Human Trace Element Requirements by WHO/FAO/IAEA. In: Trace Elements in Man and Anmals-7, 1991, pp. 13-1.

Carbohydrate Nutrition Laboratory
Beltsville Human Nutrition Research Center
Beltsville, Maryland 20705

Mission: (1) determine the effects of utilizable carbohydrates such as sucrose, fructose and starch on risk factors associated with human disease and investigate the mechanisms for their differential effects; (2) determine the effects of dietary fibers on nutrient bioavailability and to investigate the mechanisms underlying these effects; (3) determine interactions that occur between dietary carbohydrates and various minerals; and (4) determine the effects of these interactions on population groups with different genetic predisposition (e.g., carbohydrate sensitivity) in order to identify those individuals at particular risk. The information to be derived from these studies will enable the laboratory to attain its technical objective, the establishment of optimal levels for carbohydrate intake by humans and the forms that best meet these requirements, thus improving the health and quality of life in the adult and aging population.

Dr. Judith Hallfrisch
Research Leader
Supervisory Research Chemist
Room 323, Building 307
Beltsville, Maryland 20705
301/504-8396

Provides leadership to the laboratory. Studies: (1) the beneficial and detrimental effects of recent changes in the U.S. carbohydrate supply on health and performance in humans and animals; (2) mechanisms of interactions between carbohydrates and minerals; (3) differential sex and age effects of these interactions; (4) the relation of carbohydrate nutrition to heart disease, diabetes and cancer.

Dr. Kay M. Behall
Research Chemist
Room 305, Building 307
Beltsville, Maryland 20705
301/504-8682

Investigates effects of different sources of starch or fiber on metabolic risk factors associated with human diseases. Studies the effects of chemically-defined dietary fiber on metabolic and physiological processes associated with heart diseases, diabetes, bowel function and mineral balance in humans.

Dr. Sam J. Bhathena
Research Chemist
Room 324, Building 307
Beltsville, Maryland 20705
301/504-8422

Studies the effects of dietary carbohydrates on hormones involved in carbohydrate metabolism and on erythrocyte and tissue receptors of hormones such as insulin and glucagon in normal and carbohydrate-sensitive subjects and hormone and opiate receptors in obese and spontaneously hypertensive rats. Role of opiates in diabetes, obesity, food intake, satiety and food preferences in experimental animals and humans. Role of opiates and neuropeptides in copper deficiency. Modulation of peptides and neuropeptides by copper and zinc.

Dr. Otho E. Michaelis IV
Research Biologist
Room 315, Building 307
Beltsville, Maryland 20705
301/504-8417

Studies the effects of feeding various carbohydrates to experimental animals with specific genetic predisposition toward obesity, hypertension, glucose intolerance, hyperlipidemia and how diet, sex, age and genetics interact to produce metabolic and structural defects.

Dr. Bela Szepesi
Research Chemist
Room 313, Building 307
Beltsville, Maryland 20705
301/504-8489

Studies basic mechanisms by which dietary carbohydrates differentially affect the expression of genetic tendency for obesity, diabetes and degenerative diseases. Examines the functioning of metabolic controls, the alterations in these controls in various rat models of degenerative diseases and the effect and interaction of dietary carbohydrates with the above factors.

Dr. David L. Trout
Research Nutritionist
Room 328, Building 307
Beltsville, Maryland 20705
301/504-8386

Studies metabolic and gastrointestinal responses to different sources of fiber and starches. Examines health consequences of bacterial fermentation of food residues in the lower digestive tract.

RECENT RESEARCH ACCOMPLISHMENTS

Amylose Intake On Metabolic Parameters

The long-term effect of the type of starch in the diet was investigated in 24 men. Products containing cornstarch with 70% of the starch in the form of amylopectin (standard cornstarch) or amylose were each consumed for 14 weeks. Half of the subjects had elevated insulin response (HI). Results indicate that insulin levels of the HI were significantly lower after amylose when compared to amylopectin. Insulin response area was significantly lower in all subjects consuming amylose when compared to amylopectin with the greatest decrease occurring in HI. Glucose response to a starch load was similar in HI and control subjects and did not vary with the starch. Following a meal, triglyceride levels were significantly lower when subjects consumed amylose compared to amylopectin. Fasting triglycerides decreased significantly with time on diet. Cholesterol was significantly lower after amylose when compared to amylopectin after 4 weeks on each starch with similar reductions thereafter. Results indicate that chronic consumption of high amylose foods appears to normalize the insulin response of HI men. Increased starch consumption especially in the form of amylose helped decrease blood lipids, a factor associated with atherogenesis in humans.

Diabetic SHR/N-cp Rats Devolop Inner Ear Neuropathy Associated With Human Diabetes

In collaboration with the Department of Otolaryngology, University of North Carolina, School of Medicine, it was demonstrated that diabetic SHR/N-cp rats fed a high carbohydrate diet develop neuropathy of the inner ear which is similar to that reported in human diabetics. Alterations observed included significant loss of outer hair cells, capillary basement membrane thickening and ganglion loss. These alterations were not observed in nondiabetic control animals.

Insulin Secretory Patterns are Altered in Obesity and Diabetes

Adult onset diabetes and obesity are characterized by high blood glucose levels in the presence of hyperinsulinemia. We have observed three separate defects in diabetic rats namely 1) paradoxically high insulin secretion at low glucose level, 2) secretion of insulin in response to arginine in the absence of glucose, and 3) impaired response of insulin secretion to high glucose. In obese rats only first 2 defects are present. These defects can be reversed by prolonged fasting which reduces blood glucose level. Conversely, infusing normal rats with glucose for 48 hours induced these defects. Thus, our study shows that high blood sugar levels in diabetes reversibly alter insulin response.

Eating Pattern Influences a Biological Rhythm in Gastric Responses to Food

An eating pattern of many small meals per day is useful in lowering blood cholesterol and, for non-insulin-dependent diabetics, in controlling blood glucose. Apparently, many people need to avoid unusually rapid absorption of sugars and of other nutrients after large meals. One may ask if the benefits of many small meals can be achieved with a practical number of meals per day. This question was approached with animal studies of gastric emptying, the rate-limiting step in digestion and absorption in the digestive tract. After test meals, gastric emptying occurred at different rates at different times of day, and a so-called gastric emptying response rhythm was defined.

This rhythm was controlled largely by the previous eating pattern of the rats. Early findings suggest that people may be able to avoid unduly rapid absorption of nutrients by adjusting the size and timing of a total of perhaps only three or four meals per day.

Dietary Sucrose Induces Diabetic Retinopathy in Obese SHR/N-cp Rats

In collaboration with the National Eye Institute at NIH it was demonstrated that diabetic SHR/N-cp rats fed a high sucrose diet, develop retinal microangiopathies which are similar to those observed in human diabetic retinopathy. Alterations reported include proliferation of retinal capillaries and endothelial cells, pericyte loss, capillary dilation and varicose loop formation.

Obesity and Diabetes Reduce Bone Growth in Rats With the SHR/N-cp Gene

Bone length and femur weight were reduced by both obesity and diabetes. The two effects were additive so that the obese diabetic had twice the bone reduction compared to the nondiabetic obese rat. The smaller bones were weaker, but had normal density and calcium content. Calcium retention and intestinal capacity to absorb calcium were both normal in either obese or diabetic rats. Calcium regulatory hormones (calcitonin, PTH) were both elevated in diabetic rats. The results indicate the existence of a major regulatory dysfunction of the hormones that regulate bone formation as a consequence of the presence of the N-cp gene.

Trans Fatty Acids Have Deleterious Effects

Humans consume trans fatty acids through margarine and other hydrogenated oils. Those fatty acids have been shown to increase cholesterol level in humans. In monkeys, feeding 10% dietary fatty acids as trans fatty acids, we observed a decrease in the affinity of insulin receptor. However, there was no change in membrane fluidity which is normally increased by unsaturated fatty acids, and an increase in insulin receptor number. Our data show that dietary trans fatty acids are incorporated in erythrocyte membranes, and have the same effects on insulin receptor and membrane fluidity as seen with saturated fatty acids. The intake of trans fatty acids by humans, especially diabetic subjects, should be restricted. A study in humans is currently underway in collaboration with the Lipid Nutrition Laboratory, BHNRC and the Food and Drug Adminstration.

Dietary Fat and Menstrual Cycle Affect Plasma Opiates in Humans

In humans, type of dietary fat as well as level of fat in the diet alters hormones such as insulin, glucagon, cortisol, dehydroepiandrosterone-sulphate, somatomedin-C and growth hormone. We have developed a new method which is simple and rapid for the simultaneous measurement of three opiates from small volume of human blood. Using this new method, we have demonstrated that plasma opiates are altered by the amount of fat in the diet, level of unsaturation of dietary fat and the menstrual cycle changes in premenopausal women.

Atrial Natriuretic Peptide May Play a Role in the Cardiac Rupture in Copper Deficiency

Atria are now recognized as endocrine organs. They secrete atrial natriuretic peptides (ANP) which play a role in diuresis, natriuresis and hypertension. We have demonstrated sexual differences in plasma and atrial levels of ANP in copper deficient male and female rats and have postulated that an increase in plasma ANP which precedes

death from cardiac rupture may be responsible. We have further demonstrated that gonadal sex hormones are not involved in the sexual dimorphism of cardiac rupture and postulated that pituitary sex hormones may be involved. We are currently testing this hypothesis using hypophysectomized animals.

PUBLICATIONS

1989

Adamo, M., Shemer, J., Aridor, M., Dixon, J., Carswell, N., Bhathena, S.J., Michaelis, O.E. IV, LeRoith, D. Liver insulin receptor tryosine kinase activity in a rat model of type II diabetes mellitus and obesity. J. Nutr. 119:484-489, 1989.

Baly, D.L., Zarnowski, M.J., Carswell, N., Michaelis, O.E. Insulin resistant glucose transport activity in adipose cells from the SHR/N-corpulent rat. J. Nutr. 119:628-632, 1989.

Beal, T., Lewis, C.G., Fields, M. Tissue Sorbitol Concentration Can Be Altered By Changing the Type of Dietary Carbohydrate or Copper Status. FASEB J. 3:A776, 1989.

Behall, K.M. Effect of soluble fibers on plasma lipids, glucose tolerance and mineral balance. American Chemical Society 197th National Meeting, Dallas, TX, April 1989, abstract no. 2.

Behall, K.M., Scholfield, D.J., Clark, W.M., Judd, J., Nair, P.P., Schatzkin, A., Taylor, P.R. Apparent Mineral Balance After a High-Fat/Low-Fiber Diet and a Low-Fat/High-Fiber Diet. FASEB J. 3:A1066, 1989.

Behall, K.M., Scholfield, D.J., McIvor, M.E., Van Duyn, M.A., Leo, T.A., Michnowski, J., Cummings, C.C., Mendeloff, A.I. Effect of guar gum on mineral balances in NIDD adults. Diabetes Care 12:357-364, 1989.

Behall, K.M., Scholfield, D.J., Yuhaniak, I., Canary, J.J. Diets containing high amylose vs amylopectin starch: effects on metabolic variables in human subjects. Am. J. Clin. Nutr. 49:337-344, 1989.

Bhathena, S.J. Recent advances on the role of copper in neuroendocrine and central nervous systems. Med. Sci. Res. 17:537-542, 1989.

Bhathena, S.J., Berlin, E., Judd, J.T., Jones, J., Kennedy, B.W., Smith, P.M., Jones, D.Y., Taylor, P.R., Campbell, W.S., Blanchard, S., Nair, P.P. Effect of dietary fat and menstrual cycle on the erythrocyte ghost insulin receptor in premenopausal women. Am. J. Clin. Nutr. 50:460-464, 1989.

Bhathena, S.J., Berlin, E., Judd, J., Nair, P.P., Kennedy, B.W., Jones, J., Smith, P.M., Jones, Y., Taylor, P.R., Campbell, W.S. Hormones regulating lipid and carbohydrate metabolism in premenopausal women: modulation by dietary lipids. Am. J. Clin. Nutr. 49:752-757, 1989.

Bhathena, S.J., Kennedy, B.W., Jones, J., Smith, P.M., Michaelis, O.E. IV, Carswell, N., Hansen, C.T., Voyles, N.R., Recant, L. Effect of dietary carbohydrates on insulin and glucagon receptors in a new model of noninsulin-dependent diabetes SHR/N-corpulent rat. Proc. Soc. Exp. Biol. Med. 192:66-71, 1989.

Bhathena, S.J., Kennedy, B.W., Rockwood, G., Canary, J.J., Glen, M.L., Gannon, C.A., Smith, P.M. Role of Opiates in Idiopathic (Orthostatic) Edema (IOE). FASEB J. 3:A585, 1989.

Bhathena, S.J., Smith, P.M., Kennedy, B.W., Voyles, N.R., Recant, L. Simultaneous extraction of beta-endorphin and Leu- and Met-enkephalins from human and rat plasma. Life Sciences 45:901-906, 1989.

Carswell, N., Michaelis, O.E. IV, Prather, E.S. Effect of acarbose (Bay-g-5421) on expression of non-insulin dependent diabetes mellitus in sucrose-fed SHR/N-corpulent rats. J. Nutr. 119:388-394, 1989.

DeBouno, J.F., Michaelis, O.E. IV, Tulp, O.L. The effects of the intestinal glucosidase inhibitor Bay-m-1099 (Miglitol) on glycemic status of obese rats. Nutr. Res. 9:1041-1052, 1989.

Ellwood, K.C., Reiser, S., Failla, M.L., Melumzadah, M. Effect of Dietary Carbohydrates on Synthesis and Plasma Levels of Lipoproteins in LA/N-Corpulent Rats. FASEB J. 3(3), A352, 1989.

Fields, M., Lewis, C.G., Beal, T. Fetal Polyol Metabolism in Copper Deficiency. FASEB J. 3:A777, 1989.

Fields, M., Lewis, C.G., Beal, T. Accumulation of sorbitol in copper deficiency: dependency on gender and type of dietary carbohydrate. Metabolism 38:371-375, 1989.

Fields, M., Lewis, C.G., Beal, T. The type of dietary carbohydrate consumed during pregnancy and lactation determines copper status of the fetus and the neonate rat. American Chemical Society 197th National Meeting, Dallas, TX, April 1989, abstract no. 90.

Fields, M., Lewis, C.G., Beal, T. The type of dietary carbohydrate consumed during pregnancy and lactation determines copper status of the fetus and the neonate rat. In: Copper Bioavailability and Metabolism. C. Kies, ed., Plenum Publishing Corp., New York, NY, pp. 59-71, 1989.

Fields, M., Lewis, C.G., Beal, T., Berlin, E., Kliman, P.G., Peters, R.G. Blood risk factor metabolites associated with heart disease and myocardial fatty acids in copper-deficient male and female rats. Proc. Soc. Exp. Biol. Med. 191:293-298, 1989.

Hallfrisch, J., Powell, A.S., Reiser, S., Mertz, W., Prather, E. The Beltsville diet and blood pressure in normotensive men and premenopausal and postmenopausal women. Nutr. Rep. Int. 39:1139-1147, 1989.

Kennedy, B.W., Bhathena, S.J., Michaelis, O.E., Smith, P.M., Carswell, N., Kim, Y. Plasma Opiates in a Genetically Obese and Noninsulin-Dependent Diabetic Rat Model, the SHR/N-Corpulent Rat. FASEB J. 3:A927, 1989.

Koh, E.T., Reiser, S., Fields, M. Dietary fructose as compared to glucose and starch increases the calcium content of kidney of magnesium-deficient rats. J. Nutr. 119:1173-1178, 1989.

Koh, E.T., Reiser, S., Fields, M. and Scholfield, D. Copper status in the rat is affected by modes of copper delivery. J. Nutr. 119:453-457, 1989.

Lewis, C.G., Fields, M. Exocrine pancreatic function of rats consuming a high-fructose, low-copper diet. In: Copper bioavailability and metabolism. C. Kies, ed., Plenum Publishing Corp., New York, NY, pp. 219-227, 1989.

Lewis, C.G., Fields, M. Exocrine pancreatic function of rats consuming a high-fructose, low-copper diet. American Chemical Society 197th National Meeting, Dallas, Texas, April 1989, abstract no. 110.

Lewis, C.G., Fields, M., Beal, T. Sorbitol Accumulation in Male and Female Rats Consuming Starch or Fructose Diets With or Without Copper. FASEB J. 3:A775, 1989.

Lewis, C.G., Michaelis, O.E., Yang, C.Y., Carswell, N. Enzyme specific activities and mineral concentrations of the exocrine pancreas from female SHR/n-corpulent (*cp*) rats. J. Am. Coll. Nutr. 8:608-616, 1989.

Michaelis, O.E., IV, Carswell, N., Abraham, A.A. Effect of Feeding a High or Low Sucrose Diet on Expression of Diabetes in the SHR/N-Corpulent (cp) Rat. FASEB J. 3:A356, 1989.

Michaelis, O.E. IV, Carswell, N., Velasquez, M.T., Hansen, C.T. The role of obesity, hypertension and diet in diabetes and its complications in the spontaneous Hypertensive/NIH-corpulent rat. Nutrition 5:56-59, 1989.

Panda, P., Reiser, S., Canary, J. Relationship Between Dietary Copper Intake and Indices of Copper Status in Men, Premenopausal and Postmenopausal Women. FASEB 3(3), Part I, A352, 1989.

Recant, L., Voyles, N.R., Timmers, K.I., Bhathena, S.J., Solomon, D., Wilkins, S., Michaelis, O.E. IV. Comparison of insulin secretory patterns in obese non-diabetic (LA/N-*cp*) and obese diabetic (SHR/N-*cp*) rats: Role of Hyperglycemia. Diabetes 38:691-697, 1989.

Reiser, S. Simple and complex carbohydrates. In: Nutritional Status Assessment of the Individual. (G.E. Livingston, ed.), Food and Nutrition Press, Westport, CT, pp. 248-265, 1989.

Reiser, S. An interaction between copper and dietary carbohydrate. Int. Clin. Nutr. Rev. 9:16-20, 1989.

Reiser, S., Powell, A.S., Scholfield, D.J., Panda, P., Fields, M., Canary, J.J. Day-Long glucose, insulin and fructose responses of hyperinsulinemic and nonhyperinsulinemic men adapted to diets containing either fructose or high-amylose cornstarch. Am. J. Clin. Nutr. 50:1008-1014, 1989.

Reiser, S., Powell, A.S., Scholfield, D.J., Panda, P., Ellwood K.C., Canary, J.J. Comparison of blood lipids, lipoproteins, apoproteins and uric acid in men fed diets containing fructose or high amylose vs amylopectin starch on metabolic parameters in human subjects. Am. J. Clin. Nutr. 49:832-839, 1989.

Rockwood, G., Bhathena, S.J. Effects of Naltrexone on Feeding and Drinking Patterns in Rats. FASEB J. 3:585, 1989.

Scholfield, D.J., Behall, K.M., Fields, M., Beal, T., Lewis, C.G. Cardiac Catecholamines in Rats Fed Copper Deficient or Copper Adequate Diets Containing Fructose or Starch. FASEB J. 3:A769, 1989.

Servetnick, D.A., Wiesenfeld, P.L., Szepesi, B. The Possible Involvement of Insulin in the Disaccharide Effect on Lipogenesis in the Rat. FASEB J. 3(3), Part I, A704, 1989.

Szepesi, B., Kamara, A.K., Clarke, S. Lack of specificity of polyunsaturated fats in the inhibition of rat liver glucose-6-phosphate dehydrogenase. J. Nutr. 119:161-165, 1989.

Szepesi, B., Thimaya, S. Differential effects thyroxine on antagonizing the effects of dietary fat on NADP-linked dehydrogenases of rat liver. Nutr. Rep. Int. 90:745-754, 1989.

Timmers, K.I., Voyles, N.R., Wilkins, S., Michaelis, O.E. IV, Bhathena, S.J., Recant, L. Immunreactive Beta-endorphin and met- and leu-enkephalin contents in pancreas and pituitary of corpulent (cp/cp) rats. Int. J. Obesity. 13:337-345, 1989.

Trout, D.L., Bhathena, S.J., Mobarak, M.S., King, S.A. Evidence that therapeutic alterations in the circadian rhythm for gastric emptying response to food may be possible. Chronobiologia 16:191, 1989.

Trout, D.L., Mobarak, M.S. Circadian Rhythm in the Self-Selection of Fat vs. Carbohydrate in Rats Choice-Fed Nutritionally Adequate Diets. FASEB J. 3:A337, 1989.

Tulp, O.L., Hansen, C.T., Michaelis, O.E. IV. Effects of dietary carbohydrate and phenotype on thyroid hormones and brown adipose tissue locularity in adult LA/N-cp rats. Comp. Biochem. Physiol. 94A:225-229, 1989.

Velasquez, M.T., Kimmel, P.L., Michaelis, O.E. IV, Carswell, N., Abraham, A., Bosch, J.P. Effect of carbohydrate intake on kidney function and structure in the SHR/N-corpulent rat: A new model of non-insulin-dependent diabetes mellitus. Diabetes 38:679-685, 1989.

Yamini, S., Staples, R., Szepesi, B. Effect of Obesity and Dietary Carbohydrate on Liver and Kidney Urea Cycle Enzyme Activities and Plasma Amino Acids in the Rat. FASEB J. 3(3), Part I, A353, 1989.

1990

Behall, K.M. et al. Effect of type of starch and presence of fiber on glucose and insulin response of human subjects. FASEB J. 1990, V.4, No. 3, pg. A529, Abstr. 1522.

Bhathena, S.J., Smith, P.M., Kennedy, B.W., Kim, Y-C., Voyles, N.R. and Recant, L. Plasma somatostatin in a genetic syndrome of noninsulin-dependent diabetes in the SHR/N-corpulent rat. Med. Sci. Res. 18:425, 1990.

Bhathena, S.J. et al. Effect of dietary carbohydrates on plasma opiates and opiate receptors in brain of SHR/N-cp rats. In: Lessons from Animal Diabetes 3rd International Workshop pg. 39, March 1990.

Bhathena, S.J. et al. Effect of dietary fish oil and vitamin E on plasma opiates in male subjects. FASEB J. 4:A1157, 1990.

Bhathena, S.J. et al. Glucoregulatory hormonal response to dietary fish oil and vitamin E in men (Proc. 50th Ann. Mtg. Amer. Diab. Assn., June 16-19). Diabetes (Supp 1):49A, 1990.

Bhathena, S.J. and Recant, L. Copper and endocrine and neuroendocrine function. (1st Int. Symp. on Metal Ion in Biology and Medicine, May 16-19, 1990). In: Proceedings of the First Int. Sym on Trace Metals in Med., (Eds. Collery, P., Poirier, L.A., Manfait, M., and Etienne, J-C.) pp. 84, 1990.

Burns, W.A., Fields, M., Smith, C. Jr. and Reiser S. Myocardial lesions in copper deficiency modified by dietary carbohydrates. The J. of Trace Elements in Exper. Med. 3:67, 1990.

Cunnane, S.C., Fields, M. and Lewis, C.G. Dietary carbohydrate influences tissue fatty acid and lipid consumption in the copper-deficient rat. Biological Trace Element Research, Vol 23, pp. 77, 1990.

DeBolt, S.P., Michaelis, O.E., IV. and Tulp, O.L. The capacity for nonshivering thermogenesis in diabetic (NIDDM) SHR/N-cp rats. FASEB J. 4:A376, 1990.

Ellwood, K.C. and Failla, M.L. Impact of medium glucose and serum on glycogen levels in CaCo-2 cells. Fed. Proc. 3(3), A352, 1990.

Fields, M. and Lewis, C.G. Alcohol exacerbates the signs associated with copper deficiency in rats fed starch. FASEB J A510, 1990.

Fields, M. Copper-carbohydrate Interaction: Part I. Environmental Management and Health: An International Journal. Vol. 1, No. 1, pp. 19-23, 1990.

Fields, M. Copper-carbohydrate Interaction: Part II. Environmental Management and Health: An International Journal. Vol. 2, No. 2, pp. 7-13, 1990.

Fields, M. and Lewis, C.G. Alcohol consumption aggravates copper deficiency. Metabolism, Vol. 39, No. 6, pp. 610, 1990.

Fields, M., Lewis, C.G., Beal, T. and Scholfield, D. Copper deficiency in pregnancy: Effect of maternal and fetal polyol metabolites. Metabolism, Vol. 39, No. 5, pp. 531, 1990.

Fields, M. and Lewis, C.G. Metabolic pathways of dietary carbohydrates play a major role in the expression of copper deficiency. Metal Ions in Biol. and Med. (eds Collery, P., Poirier, L.A., Manfait, M., and Etienne, J-C.) pp. 80-83, 1990.

Greenhouse, D.D., Hansen, C.T. and Michaelis, O.E., IV. Development of fatty acid and corpulent rat strains. ILAR News. 32:2-4, 1990.

Kim, Y.C., Bhathena, S.J., Nair, P.P., Bhagavan, H.N., Berlin, E.T. and Judd, J.T. Hormonal response to fish oil and vitamin E during oral glucose tolerance test in healthy males. FASEB J. 4:A931, 1990.

Lewis, C.G., Fields, M. and Beal, T. Effect of changing the type of dietary carbohydrate or copper level of copper-deficient, fructose-fed rats on tissue sorbitol concentrations. J. Nutr. Biochem. 1:160, 1990.

Lewis, C.G., Beal, T., Lure, M.D. and Winick, M. The effect of type of dietary fiber and level of dietary fat on rat colon growth. FASEB J. 4:1415, 1990.

Lewis, C.G., Fields, M. and Beal, T. The effect of various levels of fructose in a copper-deficient diet on Cu deficiency in male rats. Br. J. Nutr. 63:387, 1990.

Lure, M.D., Lewis, C.G. and Fields, M. Garlic oil extract ameliorates the signs associated with copper deficiency. FASEB J. 4:731, 1990.

McKee, S.K., Tulp, O.L. and Michaelis, O.E., IV. Effect of phenotype on lipogenesis from glucose in lean and obese LA/N-cp and SHR/N-cp rats. FASEB J. 4:A376, 1990.

Michaelis, O.E., IV, Abraham, A.A., Velasquez, M.T., Kimmel, P.L. and Triana, R. Pathophysiological alterations in obese SHR/N-cp rats. Abstracts of Lessons from Animal Diabetes. 3rd International Workshop pp. 50, Jerusalem, 1990.

Michaelis, O.E., IV and Hansen, C.T. The spontaneous hypertensive/NIH corpulent rat: a new rodent model for the study of non-insulin-dependent diabetes mellitus and its complications. ILAR News. 32:19, 1990.

Michaelis, O.E, IV., Carswell, N., Velasquez, M.T., Kimmel., P.L., Abraham, A.A., Canary, J.J. and Hansen, C.T. Influence of genetic obesity, dietary carbohydrate and age on parameters of glucose tolerance and kidney and adrenal gland histology in female SHR/N-corpulent rats. Int. J. Obesity. 14:973-985, 1990.

Moser-Veillon, P.B., Yamini, S., Szepesi, B. and Michaelis, O.E., IV. Calcium and magnesium metabolism of the SHR/N-cp rats as influenced by sucrose and starch feeding. Abstracts of Immunology of Diabetes III Workshop. Lessons from Animal Diabetes Workshop. March 22, 1990, pp. 45.

Panda, P., Reiser, S. and Canary, J. The effect of copper nutriture as reflected by erythrocyte superoxide dismutase on the metabolism of various carbohydrates in humans. Fed. Proc. 393 4(3), 1990.

Peisong, H., McKee, S.K., Michaelis, O.E., IV. and Tulp, O.L. Effects of phenotype and acarbose on body composition of SHR/N-cp rats. FASEB J. 4:A375, 1990.

Rockwood, G.A. and Bhathena, S.J. Diet preferences in adult rats. Physio. and Behav. Vol. 48, pp. 79-82, 1990.

Schoenemann, H.M., Failla, M.L. and Fields, M. Consequences of copper deficiency are not differentially influenced by carbohydrate source in young pigs fed a dried skim milk-based diet. Biological Trace Element Research, Vol. 25, pp. 21, 1990.

Scholfield, D.J., Reiser, S., Fields, M., Smith, J.C., Jr., Steele, N.C., Darcey, S. and Ono, K. Dietary copper, simple sugars and metabolic changes in pigs. J. Nutr. Biochem. 1:362-368, 1990.

Scholfield, D.J., Iyengar, G.V. and Reiser, S. Long term stability of mitochondrial superoxide dismutase activity in NIST diets I-V. Fresenius J. Anal. Chem. 338:453, 1990.

Servetnik, D.A., Wiesenfeld, P.L. and, Szepesi, B. Evidence that L-arginine inhibits glycation of human serum albumin (HSA) in vitro. FASEB J. 4(3), A2576, 1990.

Silverman, S., Fields, M. and Lewis C.G. The effect of vitamin E on lipid peroxidation in the copper-deficient rat. J. Nutr. Biochem. Vol. 1, pp. 98-101, February 1990.

Silverman, S., Lewis, C.G. and Fields, M. Vitamin E does not protect the rat against the severity of copper deficiency. FASEB J. 4:722, 1990.

Szepesi, B. Carbohydrates Chapter 6. In: Nutrition Review of ILSI-NF, pp. 47-55, 1990.

Timmers, K.I., Powell, A.M., Voyles, N.R., Solomon, D., Wilkins, S.D., Bhathena, S.J. and Recant, L. Multiple alterations in insulin responses to glucose in islets from glucose infused nondiabetic rats. Diabetes 39:1436, 1990.

Velasquez, M.T., Kimmel, P.L. and Michaelis, O.E., IV. Animal models of spontaneous diabetic kidney disease. FASEB J. 4:2850-2859, 1990.

Wiesenfeld, P.W., Baldwin, J. III, Chanderbhan, R., Szepesi, B. and Michaelis, O.E., IV. Comparison of adrenal function in female SHR/N-cp rats on sucrose and starch diets. Abstracts of Lessons from Animal Diab. 3rd International Workshop, pp. 39, Jerusalem, 1990.

Wiesenfeld, P.L., Son, I., Baldwin, J. III, Szepesi, B. and Michaelis, O.E., IV. Effect of starch and sucrose feeding on intestinal sucrase, maltase and lactase activity in a genetic rat model for NIDDM. FASEB J. 4:A665, 1990.

Yamini, S., Moser-Veillon, P.B., Michaelis, O.E. IV and Szepesi, B. Effect of dietary carbohydrate on Ca and Mg metabolism in SHR/N-cp rats. FASEB J. 4(3), A1046, 1990.

1991

Bhathena, S.J., Berlin, E., Judd, J.T., Kim, Y-C, Law, J.S., Hemmige, N., Ballard-Barbash, R. and Nair, P.P. The effect omega-3 fatty acids and vitamin E on hormones involved in carbohydrate and lipid metabolism in men. Am. J. Clin. Nutr. 54:684-688, 1991.

Bhathena, S.J., Kim, Y-C., Law, J.S., Berlin, E., Judd, J.T., Reichman, M.E., Taylor, P.R. and Schatzkin, A. Effect of moderate alcohol consumption on plasma opiate levels in premenopausal women. FASEB J. 5:A936, 1991.

Bhathena, S.J., Law, J.S., Berlin, E., Judd, J.T., Bhagavan, H.N., Ballard-Barbash, R. and Nair, P.P. The effects of omega-3 fatty acids and vitamin E on hormones and opiates involved in carbohydrate and lipid metabolism in men. Presented at Fifth Conference for Federally Supported Human Nutrition Research Units and Centers. National Institutes of Health, Bethesda, Feb. 20-21, 1991.

Bhathena, S.J., Kennedy, B.W., Kim, Y.C., Michaelis, O.E., IV., Rockwood, G.R., Voyles, N.R. and Recant, L. Effect of dietary carbohydrates on plasma opiates and opiate receptors in brain of SHR/n-cp rats. In: Frontiers in Diabetes Research. Lessons from Animal Diabetes III, (ed. Shafrir, E.), pp. 387-390. Smith Gordon, London. 1991.

Bhathena, S.J., Recant, L., Voyles, N.R., Fields, M., Kennedy, B.W. and Kim, Y.C. Interaction between dietary copper and carbohydrates on neuropeptides and neurotransmitters in CNS and adrenals. In: Trace Elements in Man and Animals. 7:313-314, 1991.

Bhathena, S.J. Fatty acids and diabetes. In: "Fatty Acids in Foods and their Health Implications" ed. C.K. Chow. Marcel Dekker, Inc. Pub., Berlin. 823-855, 1991.

Ellwood, K.C., Failla, M.L. and Reiser, S. Lipoprotein status in Sprague-Dawley and LA/N-corpulent rats as affected by dietary carbohydrates. Comp. Biochem. Physiol.; 98A:323-327. 1991

Fields, M., Lewis, C.G. and Lure, M.D. Anemia plays a major role in myocardial hypertrophy of copper deficiency. Metabolism 40:1-3. 1991.

Fields, M., Lewis, C.G. and Lure, M.D. The role of the adrenals in copper deficiency. Metabolism 40:540-544. 1991.

Fields, M., Lewis, C.G., Lure, M.D., Burns, W.A. and Antholine, W.E. The severity of copper deficiency can be ameliorated by deferoxamine. Metabolism 40:105-109, 1991.

Fields, M., Lewis, C.G. and Lure, M.D. Anemia aggravates the severity of copper deficiency in experimental animals. TEMA 7(5):16-18, 1991.

Fields, M., Lewis, C.G. and Lure, M.D. Iron may play a role in pancreatic atrophy in copper deficiency. FASEB J. 5:A1077, 1991.

Fields, M. The metabolic effects of fructose. Health Media of America 9(6):41, 1991.

Greenhouse, D.D., Michaelis, O.E., IV. and McCune, S.A. The development of corpulent rat strains. In: Frontiers in Diabetes Research. Lessons from Animal Diabetes III, (ed. Shafrir, E.), pp. 375-377. Smith Gordon, London. 1991.

Harland, B.F., White, R.W., Redman, R.S. and Fields, M. Effects of copper deficiency on rat salivary gland morphology and secretory enzymes. TEMA 7(20):2-3, 1991.

Law, J.S., Bhathena, S.J., Kim, Y-C., Berlin, E., Judd, J.T., Reichman, M.E., Taylor, P.R. and Schatzkin, A. Effect of alcohol consumption on hormones involved in carbohydrate and lipid metabolism in premenopausal women. FASEB J. 5:A936, 1991.

Lewis, C.G., Fields, M. and Beal, T. The effect of age and length of feeding on the expression of the fructose-copper interaction. FASEB J. 5:A585, 1991.

Lewis, C.G, Fields, M.F. and Lure, M.D. Severity of copper deficiency in rats fed fructose is not solely dependent on hepatic copper concentration: effects of adrenalectomy. J. Nutr. Biochem. 2:97-101. 1991.

Lure, M.D., Fields, M. and Lewis, C.G. Prevention of anemia alleviates heart hypertrophy in copper deficient rats. FASEB J. 5:A585, 1991.

Michaelis, O.E., IV., Abraham, A.A., Kimmel, P.L., Velasquez, M.T., Triani, R.J. and Prazma, J. Pathophysiological alterations in diabetic spontaneous hypertensive/NIH-corpulent rats. In: Frontiers in Diabetes Research. Lessons from Animal Diabetes III, (ed. Shafrir, E.), pp. 378-380. Smith Gordon, London. 1991.

Osilesi, O., Trout, D.L., Ogunuwole, J.O. and Glover, E.G. Blood pressure and plasma lipids during ascorbic acid supplementation in borderline hypertensive and normotensive adults. Nutr. Res. 11:405-412, 1991.

Panda, P., Reiser, S., Scholfield, D.J., Behall, K.M., Ahrens, R.A. and Canary, J.J. Carbohydrate tolerance in humans as influenced by sex, age and erythrocyte superoxide dismutase activity. J. Nutr. Biochem. 2:222-228, 1991.

Recant, L., Voyles, N.R., Timmers, K.I., Wilkins, S.D., Bhathena, S.J. and Michaelis, O.E., IV. Islets from genetically obese-diabetic rats (SHR/N-cp-cp) show multiple abnormalities of insulin secretion in response to glucose. In: Frontiers in Diabetes Research: Lessons from Animal Diabetes, III. (ed. Shafrir, E.), pp. 350-354. Smith Gordon, London.

Robison, W.G., Jr., McCaleb, M.L., Feld, L.G., Michaelis, O.E., IV. and Laver, N. Degenerated intramural pericytes (ghost cells) in the retinal capillaries of diabetic rats. Current Eye Res. 10:339-350, 1991.

Russell, J.C., Amy, R.M., Michaelis, O.E., IV., McCune, S.M. and Abraham, A.A. Myocardial disease in the corpulent strains of rats. In: Frontiers in Diabetes Research. Lessons from Animal Diabetes III, (ed. Shafrir, E.), pp. 402-407. Smith Gordon, London. 1991.

Schlabach, S.J., Bhathena, S.J., Santa Maria, D.L., Mann, P.H. and Castonguay, T.W. The effects of training and detraining on dietary self-selection patterns in the Osborne-Mendel Rat. FASEB J. 5:A961, 1991.

Triana, R.J., Suits, G.W., Garrison, S., Prazma, J. Brechtelsbauer, P.B., Michaelis, O.E., IV. and Pillsbury, H.C. A model for studying hearing loss in diabetes mellitus. Arch. Otolaryngology. 117:635-640, 1991.

Trout, D.L. Vitamin C and cardiovascular risk factors. Am. J. Clin. Nutr.; 53:322S-5S. 1991.

Trout, D.L., King, S.A., Bernstein, P.A., Halberg, F. and Cornelissen, G. Circadian variation in the gastric-emptying response to eating in rats previously fed once or twice daily. Chronobiol. Int. 8:1-24. 1991.

Tulp, O.L., Hansen, C.T., McKee, S.K. and Michaelis, O.E., IV. Effects of dietary carbohydrate and phenotype on adipose cellularity in female SHR/N-cp rats. Comp. Biochem. Physiol. 99A:229-234.

Tulp, O.L., Hansen, C.T., McKee, S.K. and Michaelis, O.E., IV. Effects of diet and phenotype on adipose cellularity and 5'-deiodinase activity of liver and brown adipose tissue of diabetic SHR/N-cp rats. Comp. Biochem. Physiol. 99A:457-462, 1991.

Tulp, O.L., DeBolt, S.P., Hansen, C.T. and Michaelis, O.E., IV. Effects of dietary carbohydrate and phenotype on adipose cellularity in female SHR/N-cp rats. Comp. Biochem. Physiol. 99A:229-234. 1991.

Tulp, O.L., Szepesi, B., Michaelis, O.E., IV. and DeBouno, J.F., Jr. The effects of low dose Bay M 1099 (Miglitol) on serum lipids and liver enzyme activity of obese and obese-diabetic corpulent rats. Comp. Biochem. Physiol. 99C:241-246. 1991.

Tulp, O.L., DeBolt, S.P., McKee, S.K. and Michaelis, O.E., IV. Adaptive thermogenesis and energy metabolism in the SHR/N-cp rat. In: Frontiers in Diabetes Research. Lessons from Animal Diabetes III, (ed. Shafrir, E.), pp. 381-386. Smith Gordon, London. 1991.

Werman, M.J. and Bhathena, S.J. A colorimetric method for lysyl oxidase activity in copper deficient rats fed a high fructose diet. FASEB J. 5:A585, 1991.

Werman, M.J. and Bhathena, S.J. A sensitive and convenient colorimetric assay for measuring lysyl oxidase activity in tissues. Clin. Chem. Enzymol. Commun. 3: , 1991.

Wiesenfeld, P.W., Michaelis, O.E., IV. and Szepesi, B. Adrenal corticosterone and aldosterone production in obese, male and female, SHR/N-cp rats. FASEB J. 5:A958, 1991.

Wiesenfeld, P.W., Baldwin, J., III., Chanderbhan, R., Abraham, A., Szepesi, B. and Michaelis, O.E., IV. Comparison of adrenal function in female SHR/N-cp rats on sucrose and starch diets. In: Frontiers in Diabetes Research. Lessons from Animal Diabetes III, (ed. Shafrir, E.), pp. 391-396. Smith Gordon, London. 1991.

Energy and Protein Nutrition Laboratory
Beltsville Human Nutrition Research Center
Beltsville, Maryland 20705

Mission: To determine human energy and protein requirements as influenced by diet, activity and environment. To identify, quantify, and characterize the physiological processes involved in total energy expenditure. To identify the interactions among and the factors which control the composition of the body, energy expenditure and the source and amounts of nutrients consumed as it relates to the maintenance of desired body weight. To improve methods to predict energy values of foods from chemical or physical measurements. To characterize the metabolic responses to proteins including amino acid availability. To develop methods to indirectly assess the body composition and the energy expenditure of human subjects.

Dr. Paul W. Moe
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Supervisory Res. Physiologist
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Provides leadership to the laboratory. Development of calorimetry facilities. Adequacy of Atwater factors in human diets. Effects of diet composition on energy use. Sources of variation in energy expenditure of humans.

Dr. Joan Marie Conway
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Research focuses on the interactions of body composition, nutrient intake and energy expenditure. Utilizes stable isotopically labelled substrates to study the intermediary metabolism of protein, fat, and carbohydrate. Studies body composition changes during weight loss and in ethnic groups.

Dr. Juliette C. Howe
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Studies the effects of varying nutrient intake on energy metabolism in normal and hyperinsulinemic individuals. Determines the physiological bases of variation among individuals in resting energy expenditure.

Dr. William V. Rumpler
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Effects of diet composition, plane of nutrition and environmental factors on the regulation of substrate utilization and energy balance in humans.

Dr. James L. Seale
Research Biomedical Engineer
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Development of direct and indirect calorimetry systems. Influence of physical activity, fitness level and environmental factors and on energy expenditure. Development of stable isotope method for estimating energy expenditure on free living populations.

RECENT RESEARCH ACCOMPLISHMENTS

Energy Expenditure During the Menstrual Cycle

In studies using a canopy and bedside calorimetry system for indirect calorimetry on premenopausal women, there were no significant differences in resting energy expenditure (REE) measured at different times in the menstrual cycle. Thus changes in estradiol or progesterone had no detectable effect on REE. There was a 99% probability of detecting a difference of 7.85% in resting energy expenditure between measurements. However, similar studies in the BHNRC room-sized calorimeter showed that energy expenditure over a twenty-four hour period (24EE) differed significantly in relation to the menstrual cycle. In fact, energy expenditure during sleep (EEs) was highly influenced ($P < 0.0001$) by the menstrual cycle. Results indicated that variation in 24EE reflects primarily changes in basal energy expenditure, as suggested by EEs values, and that this basal energy expenditure is increased about 6% when progesterone levels are elevated.

Indirect Calorimetry on Ambulatory Subjects

An inexpensive, light, portable canopy was developed out of cellulose acetate. The canopy rests on a subject's shoulders, is sealed comfortably around the neck and allows casual movement. This apparatus, coupled with oxygen (conductivity) and carbon dioxide (infrared) analyzers is suitable for measuring diet-induced thermogenesis. Air enters at the bottom and is exhausted from the top of the canopy via a blower. Measured oxygen and carbon dioxide in the expired air is recorded and displayed on a personal computer.

Energy Conservation Mechanisms by Men on a Reduced Calorie Diet

Short-term calorie deficiency diets are frequently utilized by people wishing rapid weight change. In this controlled study, healthy men were stabilized on their usual calorie intake for two weeks (3426 kcal/d) and then changed to a 50% reduced calorie content for the subsequent four weeks. Comparison of protein synthesis and glucose substrate cycling at the ends of the high and low calorie diet periods showed that an estimated 13% of the decrease in energy intake could be compensated for by decreased body weight (about 6%), decreased protein synthesis (about 6%) and reduced cycling (about 1%). The remaining 87% was met by the oxidation of body fat.

Metabolizable Energy Differences Between Low Fat, High Fiber and High Fat, Low Fiber Diets

The digestibility of the energy and energy-containing nutrients was significantly lower in normal male subjects fed a low fat, high (64.8 g/day) fiber diet compared with a high fat, low (33.6 g/day) fiber diet. Fiber was supplied mainly from grain and cereal products. The metabolizable energy of these diets calculated from the U.S. food tables overestimated the measured metabolizable energy by a mean of 5%.

Magnetic Resonance Imaging (MRI), a New Method for Assessing Changes in Adipose Tissue During Weight Reduction

MRI is a non-invasive technique for direct measurement of adipose tissue, muscle and bone. Thus this technique was used to determine the patterns of mobilization of adipose tissue during weight reduction in men on a 12 week calorie reduction diet. Adipose tissue volume was measured at the mid-point and termination of the study at

several body sites (arm, abdomen, hip, thigh, calf) and in addition % body fat and liver volume were measured. At the end of the diet period, there was a 13% reduction in weight, 30% reduction in percent fat, and a mean of 32% reduction in adipose tissue volume, which was not uniform at all measurement sites. Liver volume did not change.

Changes in Energy Expenditure, Energy Balance and Body Fat Due to Calorie-restricted Diets

Normal male subjects were maintained on 3426 kcal/day diets containing either 20% or 40% calories from fat and then switched to 1763 kcal/d (50% for maintenance) for 4 weeks. During the reduced calorie period, there was a significant decrease in weight (96.6 to 91.5 kg); body fat (30.4 to 27.7%) and 24 hour energy expenditure as measured by indirect calorimetry (2902 to 2709 kcal/d). There was a significant diet effect on respiratory quotient (RQ): a decline of 0.84 to 0.82 on the high fat diet and 0.88 to 0.84 on the low fat diet. There was no effect on the type of fat diet during the reduction period on 24 hour energy expenditure or changes in body composition.

Moderation of Carbohydrate and Lipid Metabolism With Dietary Amylose

The response of insulin, glucose, triglycerides and cholesterol to long-term consumption of high (70%) amylose starch products was determined in normal and hyperinsulinemic subjects. At the end of 12 weeks on diet, all subjects on the high amylose diet showed reduced postprandial insulin responses to a starch tolerance test when compared to the high amylopectin diet ($P < 0.002$). The reduction in insulin response was of a greater magnitude in hyperinsulinemic ($P < 0.001$), than in normal ($P > 0.17$), subjects. Fasting triglyceride levels were reduced ($P < 0.0003$) with time on diet, but fasting cholesterol levels remained unchanged. The results indicate that insulin levels of hyperinsulinemic men may be normalized following chronic consumption of high amylose containing foods. Increased starch consumption, particularly in the form of amylose, may help decrease blood lipids, a factor associated with atherogenesis in humans.

Performance of BHNRC Room Sized Calorimeter

The Energy and Protein Nutrition Laboratory at BHNRC has two operational room sized calorimeter chambers. The dual direct/indirect calorimeter is 3.66m x 3.29m x 2.93m (volume $20m^3$) and is designed to measure (1) the actual heat emitted by a person within the room (direct calorimetry) and (2) heat production estimated from the oxygen consumed and carbon dioxide produced as a consequence of breathing the air circulated in the sealed chamber (indirect calorimetry). A water cooled gradient layer surrounds the chamber and provides the direct calorimetry measurement. Air composition and circulation rate are measured to determine the indirect calorimetry values. The second room sized chamber is a 3.41m x 3.41m x 2.93m (volume $21m^3$) indirect calorimeter. A computer automated data acquisition and control system is used to measure heat emission, air composition, temperatures, pressures and subject activity continuously in both chambers while the system is in operation. Performance tests indicate that the direct calorimeter determines heat emission with 97.3% and the indirect calorimeter measures heat production with 100.3% accuracy. To date approximately 800 24-hr energy expenditure measurements have been made on human subjects.

Storage Efficiency of Excess Energy Intake

The efficiency of storage of metabolizable energy intake above maintenance was determined in individuals on high and low fat maintenance diets. Subjects were fed a high fat basal diet (HFB) or low fat (LFB) at maintenance. The diets were then additionally supplemented with either fat or carbohydrate at 25% above maintenance. Respiratory Quotient (RQ) averaged .81 and .89 for the HFB and LFB respectively. With the addition of fat the RQ declined slightly to .80 and .87 for HFB + fat and LFB + fat respectively. When carbohydrate was added the RQ increased to .86 and .95 for HFB + carbohydrate and LFB + carbohydrate. Examination of substrate oxidation demonstrates that the addition of carbohydrate had a fat sparing effect regardless of diet. Also, the addition of fat resulted in an increase in fat oxidation.

Energy Expenditure Measured with Doubly Labeled Water in Free Living Adults Validated and Compared to Calorimetry

The doubly labeled water method as practiced at BHNRC was validated using the room calorimeter. The doubly labeled water method can be used to measure energy expenditure in free living adults over a one to two week period with minimal interference in the subjects' normal activities. For the purpose of validating this method nine subjects were given a dose of deuterium and oxygen-18 (nonradioactive, naturally occurring stable isotopes) and housed in the room calorimeter for a one week period. The doubly labeled water results were then compared to calorimetry results for that period. Free living energy expenditure was also determined for the one week period after the subjects left the chamber. Results indicate that the doubly labeled water method as practiced at BHNRC is accurate to 1.58% $\pm$ 1.72% (Mean $\pm$ SEM). Free living energy expenditure was 14% greater than the energy expenditure measured in the controlled restricted environment of a room sized calorimeter. These results compare favorably with the 15% greater free living energy expenditure determined in four adult men in a previous study.

Energy Expenditure, Water Turnover, Metabolizable Energy, Nitrogen Balance and Protein Synthesis During 150 and 1000 ft Saturation Dives

Energy expenditure, water turnover rate, urinary output, metabolizable energy, nitrogen balance and protein synthesis were measured as part of a study to determine nutrient requirements for divers in deep saturation dives. Navy divers were studied for 10 to 14 days on the surface and during dry saturation dives in a helium-oxygen environment at depths of 150 and 1000 feet. Energy expenditure and water turnover were measured using the doubly labeled water method. Metabolizable energy and nitrogen balance were measured from analysis of duplicate meals, urine and feces. Protein synthesis was measured using ammonia and urea endpoint methods following a N15-glycine dose. Results indicate that energy expenditure increased by 12% at 150 feet and 14% at 1000 feet. There was no consistent change in water turnover. Metabolizable energy was not affected by the saturation environment and divers were in a positive nitrogen balance. Protein synthesis increased by 42% at 150 feet and 50% at 1000 feet. The helium-oxygen environment places a thermal stress on divers which accelerates metabolic rate at 150 feet. Additional respiratory and thermal stress may account for the higher metabolic rates observed at 1000 feet.

Fat Patterning in Blacks

Anthropometry is frequently used as a rapid, inexpensive, non-invasive method of determining body composition. Generalized skinfold equations that were developed in

white populations were cross-validated in 90 blacks and 89 whites, with deuterium oxide dilution as the criterion reference method. It was determined that log-transformed, age and sex-specific equations developed by Durnin and Womersley successfully predicted body fat in our black population. In addition lower triceps-subscapular and thigh-subscapular ratios in black females and lower suprailiac-subscapular ratios in black males and females were found. It was therefore concluded that blacks may have more visceral and upper-body fat deposition than whites. This fat deposition pattern may be related to the increased incidence of hypertension and diabetes in blacks.

Carbohydrate Restriction during Exercise

Sedentary, weight trained, and aerobically trained men were fed a high carbohydrate and moderately restricted carbohydrate diet. Ability to lift weights, time to fatigue, and exercise performance were not affected by carbohydrate restriction in any of the groups.

PUBLICATIONS

1989

Bodwell, C. E. An evaluation of dietary energy substrates. Book chapter in Dietary Fat Requirements in Health and Development. Joyce Beare-Rogers, ed. pp. 55-72. Am. Oil Chem. Soc., Champaign, Ill. 1989.

Bodwell, C. E., Carpenter, K. J. and McDonough, F. E. A collaborative study of methods of protein evaluation: introductory paper. Plt. Fds. Hum. Nutr. 39:3-12. 1989.

Conway, J. M., Wang, P. C., Lo, B. S., Zeman, R. K. and Canary, J. J. A new method for assessing changes in adipose tissue volume during weight reduction by magnetic resonance imaging (MRI). FASEB J. 3:A335. (Abstract). 1989.

Hitchins, A. D. and McDonough, F. E. Prophylactic and therapeutic aspects of fermented milk. Am. J. Clin. Nutr. 49:675-684. 1989.

Hitchins, A. D., McDonough, F. E. and Wells, P. A. The use of Escherichia coli mutants to measure the bioavailability of essential amino acids in foods. Plt. Fds. Hum. Nutr. 39:109-120. 1989.

Howe, J. C. and Rumpler, W. V. Resting energy expenditure in the premenopausal woman: Variation within one menstrual cycle. FASEB J. 3: A350 Abstract. 1989.

McDonough, F. E., Bodwell, C. E., Hitchins, A. D. and Staples, R. C. Bioavailability of lysine in selected foods by rat growth assay. Plt. Fds. Hum. Nutr. 39:67-75. 1989.

McDonough, F. E., Bodwell, C. E., Wells, P. A. and Kamalu, J. A. Bioavailability of tryptophan in selected foods by rat growth assay. Plt. Fds. Hum. Nutr. 39:85-91. 1989.

McDonough, F. E., Bodwell, C. E., Staples, R. C. and Wells, P. A. Rat bioassays for methionine availability in 16 food sources. Plt. Fds. Hum. Nutr. 39:77-84. 1989.

Miles, C. W. Effects of vegetable proteins on iron and zinc absorption and availability in humans. J. Am. Oil Chem. Soc. 66:924-931. 1989.

Miles, C. W. The metabolizable energy of human diets differing in fiber and fat content. FASEB J. 3:A1065 (Abstract). 1989.

Moe, P. W. Methodology and techniques: Introductory comments to discussion session. Energy Metabolism of Farm Animals, E.A.A.P. Publ. 43:374-376. 1989.

Moe, P. W. New developments in the measurement of energy expenditure. Energy Metabolism of Farm Animals, E.A.A.P. Publ. 43:333-336. 1989.

Rumpler, W. V., Seale, J. L. and Conway, J. M. Energy expenditure, energy balance and composition of weight loss in men fed on high and low fat diets. FASEB J. 3:A355 Abstract. 1989.

Rumpler, W. V., Seale, J. L., Bodwell, C. E. and Conway, J. M. The long and short term effects of caloric restriction on energy expenditure in human subjects. Energy Metabolism in Farm Animals, E.A.A.P. Publ. 43:275-278. 1989.

Seale, J. L., Miles, C. W. and Bodwell, C. E. Sensitivity of methods for calculating energy expenditure by use of doubly labeled water. J. Appl. Physiol. 66:644-652. 1989.

Seale, J. L., Rumpler, W. V. and Conway, J. M. Comparison of energy expenditure determination by direct/indirect calorimetry and doubly labeled water in adult men. Energy Metabolism in Farm Animals, E.A.A.P. Publ. 43: 337-340. 1989.

Stein, T. P., Leskiw, M. J., Schluter, M. D., Staples, R. S., Rumpler, W. V. and Bodwell, C. E. Energy conservation mechanisms on a reduced calorie diet. FASEB J. 3:A1259 Abstract. 1989.

Wells, P. A., McDonough, F. E., Bodwell, C. E. and Hitchins, A. D. The use of Streptococcus zymogenes for estimating tryptophan and methionine bioavailability in 17 foods. Plt. Fds. Hum. Nutr. 39:121-127. 1989.

Wiley, E. R. and Canary, J. J. Collagen crosslinking in metabolic bone disorders. FASEB J. 3:A267 Abstract. 1989.

Wong, N. P., Miles, C. W., Rumpler, W. V. and Seale, J. L. A canopy system designed to measure diet-induced thermogenesis by indirect calorimetry. FASEB J. 3:A703. Abstract. 1989.

1990

Albanes, D., Conway, J. M., Taylor, P. R., Moe, P. W. and Judd, J.T. 1990. Validation and comparison of eight physical activity questionnaires. Epidemiology. 1:65-71.

Anonymous. 1990. Joint FAO/WHO Expert Consultation on Protein Quality Evaluation. Food and Agriculture Organization of The United Nations.

Conway, J. M., Thorp, J. W., Stein, T. P., Seale, J. L. and Rumpler, W. V. 1990. Decreased protein synthesis during saturation diving. Am. J. Clin. Nutr. 51:512. (Abstract)

Howe, J. C. 1990. Nutrient interactions with calcium. Nutrition. 6:345.

Howe, J. C. 1990. The postprandial response of calcium metabolism in postmenopausal women to single meals varying in protein level and source. Metabolism. 39:1246-1252.

McDonough, F. E., Steinke, F. H., Sarwar, G., Eggum, B. O., Bressani, R., Huth, P., Barbeau, W. and Mitchell, G. V. 1990. In vivo rat assay for true protein digestibility: Collaborative study. J. Assoc. Off. Anal. Chem. 73:801-805.

McDonough, F. E., Sarwar, G., Steinke, F. H., Slump, P., Garcia, S. and Boisen, S. 1990. In vitro assay for protein digestibility: Interlaboratory study. J. Assoc. Off. Anal. Chem. 73:622-625.

Miles, C. W., Wong, N. P., Rumpler, W. V. and Wells, P. A. 1990. Effect of circadian variation in energy expenditure on the thermic effect of food. FASEB J. 4:A381. (Abstract)

Rumpler, W. V., Seale, J. L., Conway, J. M. and Moe, P. W. 1990. Repeatability of 24 hour energy expenditure measurements in humans by indirect calorimetry. Am. J. Clin. Nutr. 51:147-152.

Sarwar, G. and McDonough, F. E. 1990. Evaluation of protein digestibility- Corrected amino acid score for assessing protein quality of foods. J. Assoc. Off. Anal. Chem. 73:347-356.

Seale, J. L., Conway, J. M., Rumpler, W. V and Thorp, J. W. 1990. Energy expenditure and water turnover rate during a 10-day dry saturation dive. FASEB J. 4:A854. (Abstract).

Seale, J. L., Rumpler, W. V., Conway, J. M. and Miles, C. W. 1990. Comparison of energy expenditure estimations using doubly labeled water, intake balance, and direct/indirect calorimetry methods in adult men. Am. J. Clin. Nutr. 52:66-71.

Tremblay, A., Seale, J. C., Almeras, N., Conway, J. M. and Moe, P. W. 1990. Daily energy intake and expenditure in a postobese small eater. FASEB J. 4:A783. (Abstract)

Wiley, E. R., Vestal, J. H. and Rumpler, W. V. 1990. Energy expenditure and body composition of rats after restriction and refeeding of isoenergetic diets. FASEB J. 4:A377. (Abstract)

Wong, N. P., Miles, C. W., Rumpler, W. V. and Wells, P. A. 1990. Continuous measurements of the thermic effect of food in subjects while being fed. FASEB J. 4:A381. (Abstract)

Zillikens, M. C. and Conway, J. M. 1990. Anthropometry in Blacks: The applicability of generalized skinfold equations and differences in fat patterning between Blacks and Whites. Am. J. Clin. Nutr. 52:45-51.

1991

Conway, J. M. Body composition and fat patterning changes during weight loss in women of differing waist to hip ratios. FASEB J. 53:756. (Abstract). 1991.

Conway, J. M. Body Composition in Blacks. Letter to Editor. Amer. J. Clin. Nutr. 53:796. 1991.

Conway, J. M. Book Review: Human Energy Requirements. Amer. J. Clin. Nutr. 53:1506. 1991.

Conway, J. M., Thorp, J. W., Stein, T. P., Seale, J. L. and Rumpler, W. V. Decreased protein synthesis during saturation diving. 1991 Undersea and Hyperbaric Medical Society. 18:95-96. 1991.

Howe, J. C., Rumpler, W. V. and Seale, J. L. Twenty-four hour energy expenditure in relation to the menstrual cycle. FASEB J. 5(6):A1648. (Abstract). 1991.

Miles, C. W. The metabolizable energy of human diets differing in dietary fat and fiber measured in humans. J. Nutr. 2:306-311. 1991.

Rumpler, W. V. Discussion summary of session 1: Organ and Tissue Metabolism. 12th Symposium on Energy Metabolism of Farm Animals. EAAP Publ. 58:88. 1991.

Rumpler, W. V., Kressler, L. L., Baer, D. J. and Howe, J. C. Determination of body composition of live rats by electromagnetic conductance. 12th Symposium on Energy Metabolism of Farm Animals. EAAP Publ. 58:253-256. 1991.

Rumpler, W. V. and Seale, J. L. Energy expenditure and substrate oxidation in humans on high or low fat diets overfed fat or carbohydrate. FASEB J. 50:A 1650. (Abstract). 1991.

Rumpler, W. V., Seale, J. L., Miles, C. W. and Bodwell, C. E. Energy-intake restriction and diet-composition effects on energy expenditure in men. Am. J. Clin. Nutr. 53:430-6. 1991.

Rumpler, W. V., Thorp, J. W., Seale, J. L., Conway, J. M. and Haberman, K. J. Metabolizable energy intake and nitrogen balance during saturation dives. 1991 Undersea and Hyperbaric Medical Society. 18:95. 1991.

Seale, J. L. and Conway, J. M. Seven-day validation of doubly labeled water for measuring energy expenditure using a respiratory calorimeter. FASEB J. 5 (6):A1648. 1991.

Seale, J. L., Rumpler, W. V. and Moe, P. W. Description of a direct/indirect room sized calorimeter. Am. J. Physiol. 260:E306-E320. 1991.

Seale, J. L., Rumpler, W. V., Conway, J. M., Thorp, J. W. and Haberman, K. J. Energy expenditure and water and urine production at the surface and during saturation dives at 5.5 and 31 atmospheres (ATA). 1991 Undersea and Hyperbaric Medical Society. 18:94-95. 1991.

Stein, T. P., Rumpler, W. V., Leskiw, M. J., Schluter, M. D., Staples, R. and Bodwell, C. E. Effect of reduced dietary intake on energy expenditure, protein turnover, and glucose cycling in man. Metabolism. 40:478-483. 1991.

Thorp, J. W., Seale, J. L., Conway, J. M., Rumpler, W. V. and Haberman K J. Energy expenditure and body composition in healthy, fit men. Suppl. Am. J. Clin. Nutr. 53:P-29. 1991.

Thorp, J. W., Seale, J. L., Conway, J. M., Rumpler, W. V., Haberman, K. J. and Doubt, T. J. Weight and body composition during 31 atmosphere (ATA) saturation dive. Undersea and Hyperbaric Medical Society, Inc. 18:94. 1991.

Tremblay, A., Seale, J. L., Almeras, N., Conway, J. M. and Moe, P. W. Energy requirements of a postobese man reporting a low energy intake at weight maintenance. Am. J. Clin. Nutr. 54:506-8. 1991.

Yamini, S., Staples, R. C., Hansen, C. T. and Szepesi, B. Effect of dietary carbohydrate on liver and kidney enzyme activities and plasma amino acids in the la/n-cp rat. International Journal of Obesity. 15:189-203. 1991.

Zillikens, M. C. and Conway, J. C. The estimation of total body water by bioelectrical impedance analysis in Blacks. Amer. J. of Human Biol. 3:25-32. 1991.

Lipid Nutrition Laboratory
Beltsville Human Nutrition Research Center
Beltsville, Maryland 20705

Mission: Determine effects of both kind and amount of dietary fat on metabolic and related physiological parameters in humans so that recommendations on optimal intake of fat and its constituent fatty acids are consistent with life-long maintenance of good health without adversely affecting quality of life.

Lack of knowledge of how other macro nutrients and non-nutritive components of the diet interact with lipids limits our ability to predict how different intake patterns will affect an individual. A major deficit in our understanding is how the relative amounts of the macro nutrients in the diet affect micro nutrient requirements for people of different ages. We also do not know how nutrient balance in foods or mixed diets affects bioavailability of micro nutrients.

The laboratory pursues this mission using free-living human volunteers and experimental animal models to: (1) investigate needs for essential fatty acids under different physiological conditions; (2) investigate the bioavailability of vitamins involved in lipid metabolism; and (3) investigate dietary lipid and cholesterol effects on physiological parameters related to good health.

Dr. Joseph T. Judd
Research Leader
Supervisory Research Chemist
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Provides leadership to the laboratory. Current research includes investigating the role of lipids in the human diet in areas of critical importance to human health and well being.

Dr. Elliott Berlin
Research Chemist
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Investigates the effects of changes in the dietary fatty acids including saturated monounsaturated, omega -3 and other polyunsaturated fatty acids on physical chemical properties of circulating plasma lipoproteins and cell and organelle membranes as related to the prevention of heart disease, cancer, and diabetes. Particularly interested in control of membrane fluidity and the relationship of fluidity to membrane physiology, e.g. receptor binding and receptor-ligand transport in membranes.

Dr. Beverly A. Clevidence
Research Nutritionist
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Determines the effects of dietary variables, particularly type and amount of fat, on plasma lipoprotein and apolipoprotein levels of healthy human subjects eating controlled diets. Investigates the influence of dietary variables on levels of alpha-tocopherol in plasma and distribution of this vitamin among lipoproteins.

Dr. Aldo Ferretti
Research Chemist
Room 122, Building 308
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Investigates the biochemical mechanisms responsible for the physiological effects of dietary lipid modifications by studying the associated qualitative and quantitative changes of eicosanoid metabolism of essential fatty acids.

Dr. Padmanabhan P. Nair
Research Chemist
Room 105, Building 308
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Conducts research on dietary lipids and their influence on human health, especially as related to dietary factors and the causation and/or prevention of cancer; and also the role of nutrition in delaying the process of aging, with special references to the susceptibility to carcinogenesis. Determines relationship of dietary fat and other nutrients to age-related disorders as reflected by changes in sterol and bile acid metabolism, fecal mutagenesis and glutathione sulfotransferase.

Dr. Norberta W. Schoene
Research Chemist
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Investigates the relationship between essential fatty metabolism and prostaglandin production. Utilizes intact cells, especially blood platelets, to study the influences of diet on alterations in the production of these hormone-like lipids derived from essential fatty acids. Investigates the effects of dietary nutrients on cellular responses modulated by prostaglandins, e.g. platelet aggregation.

Dr. John J. Podczasy
Research Chemist
(Post Doc with Dr. Schoene)
Room 112, Building 308
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Conducts research on the effects of dietary fatty acids on the receptor-mediated generation of the intracellular ionized calcium signal. Correlates the calcium signal with other intracellular messengers to establish mechanisms of cellular transduction that result in specific physiological responses of blood platelets that can be modulated by dietary fat.

RECENT RESEARCH ACCOMPLISHMENTS

Rats Fed Lithocholic Acid Show Increased HDL-Protein and HDL-Cholesterol

Rats fed low (20%) fat diets for 8 weeks containing 0.25% lithocholic acid had increased HDL-protein (106 vs. 88 mg%) and HDL-cholesterol (62 vs. 44 mg%); and a significant reduction in binding of human ^{125}I-HDL to hepatic membranes. These and associated data suggest that lithocholic acid may down-regulate hepatic HDL receptor activity and influence HDL metabolism thus elevating HDL-cholesterol.

Characterization of Extracellular Cholesterol-Rich Particles in Human Atherosclerotic Lesions

Two types of cholesterol-containing particles were isolated from human atherosclerotic aortas and found to differ in that one is enriched with esterified and contains palmitate, oleate and linoleate as major fatty acids while the other is enriched with unesterified cholesterol and contains an additional fatty acid (stearate). The predominant phospholipid in both particles is sphingomyelin (56%).

Bioavailability of Two Forms of Fish Fatty Acids Ingested by An Animal Model

Increases in dietary n-3 polyunsaturated fatty acids from fish oils have been recommended. In order to ingest considerable amounts of these oils, needed some individuals, a fish oil supplement may be needed. Odor and mouth feel of these oils are objectionable to some people. Using a rat animal model fed these fatty acids from menhaden fish, either in the form of free oil or the same oil contained in a digestible matrix microencapsulation, we showed that after one week on either of these controlled diets, bioavailability from either source to blood plately polyunsaturated acids is equal. Thus, microencapsulation is a promising delivery system for human studies.

Quantitative Differences in Prostaglandins in Humans on High and Low-Fat Diets

A quantitative assay to estimate whole body synthesis of prostaglandins was developed and used to study differences attributed to dietary fat content. Men were fed either a high fat diet reflective of the current typical American diet 9.3% energy from polyunsaturated fatty acids) or a low-fat diet recommended to reduce risk from atheriothrombotic disorders and certain forms of cancers (6.6% energy from polyunsaturated fatty acids). Men on the low-fat diet showed an average of 14.2% reduction in daily prostaglandin output.

Markers for Nutritonally-Related Aging Processes

Using biotechnological techniques, a quantitative procedure was developed for assessing mutagenicity changes in human stools that are responsive to dietary changes. Using this technique, fecal mutagenicity (marker for risk of colon cancer) was measured in subjects fed a typical high fat (40% energy) diet or a recommended low fat diet (20% energy). Our findings showed that lowering the fat content of diets decreased fecal mutagenicity, thereby clearly supporting the view that dietary fat could be a determinant of cancer risk.

PUBLICATIONS

1989

Berlin, E., Bhathena, S.J., Judd, J.T., Nair, P.P., Jones, D.Y. and Taylor, P.R. Dietary fat and hormonal effects on erythrocyte membrane fluidity and lipid composition in adult women. Metabolism, 38:790-796, 1989.

Berlin, E., Bhathena, S.J., Kliman, P., and Revett, K. Effect of saturation of dietary lipids on insulin receptors and membrane fluidity in rabbit erythrocytes. Nutr. Repts. Intl. 39, 367-381, 1989.

Berlin, E., Bhathena, S.S., Judd, J.T. and Taylor, P.R. Dietary lipid influence on erythrocyte membrane composition, fluidity and insulin receptor binding. Colloque INSERM, 195:187-196, 1989.

Chao, F.F., Blanchette-Mackie, E.J., Dickens, B.F., Berlin, E., Skarlatos, S.I., Chen, Y-J., Resau, J.H., Amende, L.M., Mergner, W.T. and Kruth, H.S. Characterization of extracellular cholesterol-rich particles in human atherosclerotic lesions. FASEB J. 3:A5761, 1989.

Clevidence, B.A., Lehmann, J. Alpha- and gamma- tocopherol levels in lipoproteins fractionated by affinity chromatography. Lipids 24:137-140, 1989.

Ferretti, A. Validity and pitfalls of primary prostaglandin excretion in male subjects. The 1989 Intern'l Chemical Congress of Pacific Basin Societies. Book of Abstracts, Biosci. and Techn. Section, Abstract No. 202, 1989.

Ferretti, A. and Flanagan, V.P. Aspirin-like effect of omega-3 polyunsaturates on human cyclooxygenase activity. The 1989 Intern'l Chemical Congress of Pacific Basin Societies. Book of Abstracts, Biosci. and Techn. Section, Abstract No. 201. 1989.

Ferretti, A., and Flanagan, V.P. Evidence for in vivo human cyclooxygenase metabolism of timnodonate to prostaglandin E_3 during long-term MaxEPA dietary supplementation. J. Am. Oil Chem. Soc. 64:635-636, 1989.

Ferretti, A., Flanagan, V.P. and Maida, E.J. GC-MS assay for 9a,15(S)-dihydroxy-11-oxo-thromba-5(Z),13(E)-dien-1-oic acid. Analytical Letters. 22:2323-2334, 1989.

Ferretti, A., Flanagan, V.P. and Maida, E.J. Quantitative analysis of 11-dehydro-thromboxane B_2. XVI Annual Meeting, Feder. Analyt. Chem. and Spectroscopy Societies. Book of Abstracts, Abstract No. 398, pg. 111, 1989.

Ferretti, A., Judd, J.T., Taylor, P.R., Schatzkin, A. and Brown, C. Dietary lipid intake is a determinant of prostaglandin E_2 synthesis in vivo. 197th National Amer. Chem. Soc. Meeting. Biochemistry 28:1946, 1989.

Ferretti, A., Judd, J.T., Taylor, P.R., Schatzkin, A. and Brown, C. Modulating influence of dietary lipid intake on the prostaglandin system in adult men. Lipids 24:419-422, 1989.

Judd, J.T., Marshall, M.W., and Dupont, J. Relationship of dietary fat to plasma fatty acids, blood pressure, and urinary eicosanoids in adult men. Am. J. Col. Nutr. 8:386-399, 1989.

Kessie, G., Loo, G., Berlin, E. and Nair, P.P. Modulation of plasma cholesterol and hepatic high density lipoprotein receptor binding in the rat by lithocholic acid. FASEB J. 3:A4258, 1989.

Loo, G., Kliman, P.G., Wong, H.Y.C., Berlin, E., Peters, R.C., Zhuang, H. and Sherief, H.T. Lipoprotein profile in the cockerel fed an atherogenic diet. FASEB J. 3:A4259, 1989.

Marshall, M.W., Clevidence, B.A., Thompson, R.H. and Judd, J.T. Problems in estimating amounts of food cholesterol: Three methods for mixed diets. J. Food Comp. Anal. 2:2-12, 1989.

Reddy, P.P., Clevidence, B.A., Berlin, E., Taylor, P.R., Bieri, J.G. and Smith, J.C. Plasma carotenoid and vitamin E profile of lipoprotein fractions of men fed a controlled typical U.S. diet. FASEB J. 2:A4235, 1989.

Robinson, A., Hoover, R.N., Rosenthal, J., Weil, R., Nair, P.P., Schwartz, S., Pettigrew, H., Batist, G., Shaw, R. and Wilkins, T.D.: Case-control study of colorectal cancer and fecal mutagenicity. Cancer Res. 49, 3420-3424, 1989.

Schiffman, M., Van Tassell, R., Andrews, A.W., Wacholder, S., Daniel, J., Robinson, A., Smith, L., Nair, P.P. and Wilkins, T.D.: Fecapentaene concentration and mutagenicity in 718 North American stool samples. Mutation Res. 222: 351-357, 1989.

Schiffman, M., Van Tassell, R., Robinson, A., Smith. L., Daniel, J., Hoover, R., Weil, R., Rosenthal, J., Nair, P., Schwartz, S., Pettigrew, H., Curiale, S., Batist, G., Block, G., and Wilkins, T. Case-control study of colorectal cancer and fecapentaene excretion. Cancer Research 49, 1322-1326, 1989.

Schoene, N.W. and Church, J.P. Hydrogen peroxide-induced shape change in platelets: Inhibition by prostacyclin, aspirin, nitrendipine and nicotinamide. Biology of Cellular Transducing Signals '89, Ninth International Washington Spring Symposium, May 8-12, George Washington University, No. 300, 1989. (Abstract)

1990

Albanes, D., Conway, J., Taylor, P., Moe, P. and Judd, J. Validation and Comparison of eight physical activity questionnaires. Epidemiol. 1:65-71, 1990.

Albaugh, G.P., Iyengar, V., Lohani, A. and Nair, P.P. Recovery of exfoliated colonic epithelial cells from human stools by density gradient centrifugation. FASEB J. 4:5223, 1990.

Ausman, L., Johnson, J.A., Guidry, C. and Nair, P.P. Fecal sterol and bile acid content in cancer-prone Cotton-top Tamarins (Sanguius oedipus) fed high and low fat diets. FASEB J. 4:5278, 1990.

Barnard, D.E., Sampugna, J., Berlin, E., Bhathena, S.J. and Knapka, J.J. Dietary trans fatty acids modulate erythrocyte membrane fatty acyl composition and insulin binding in monkeys. J. Nutr. Biochem., 1:190-195, 1990.

Berlin, E., Bhathena, S.J., Judd, J.T., Nair, P.P., Ballard-Barbash, R. and Taylor, P.R. Steady state polarization and modulation lifetimes of DPH fluorescence in erythrocyte membranes from adult men following dietary supplementation with omega-3 fatty acids and vitamin E. 10th Intl. Biophysics Congress. 1990. ABSTRACT

Berlin, E., Bhathena, S.J., Judd, J.T., Nair, P.P., Bhagavan, H.N., Ballard-Barbash, R. and Taylor, P.R. Effects of omega-3 fatty acid and vitamin E supplementation on erythrocyte membrane fluidity and insulin binding in adult men. FASEB J. 4:3859, 1990.

Bhathena, S.J., Kim, Y.C., Judd, J.T., Berlin, E., Nair, P.P., Law, J.S., Rockwood, G.A., Bhagavan, H.N. and Ballard-Barbash, R. Glucoregulatory hormonal response to dietary fish oil and vitamin E in men. Diabetes, 39 (Suppl 1) :49A 1990. ABSTRACT

Bhathena, S.J., Kim, Y.C., Law, J.S., Rockwood, G., Berlin, E., Nair, P.P., Judd, J.T. and Ballard-Barbash, R. Effect of dietary fish oil and vitamin E on plasma opiates in male subjects. FASEB J. 4:5179, 1990.

Chao, F.F., Blanchette-Mackie, E.J., Chen, Y.J., Dickens, B.F., Berlin, E., Amende, L.M., Skarlatos, S.I., Gamble, W., Resau, J.H., Mergner, W.T. and Kruth, H.S. Characterization of two unique cholesterol-rich lipid particles isolated from human atherosclerotic lesions. Am. J. Pathol. 136:169-179, 1990.

Church, J.P., Schoene, N.W., Judd, J.T., Nair, P.P., Ballard-Barbash, R. and Taylor, P.R. Influence of long chain n-3 fatty acid intake on n-3/n-6 ratio in platelet phospholipids of subjects on controlled diets. FASEB J. 4:3075, 1990.

Clevidence, B., Judd, J., Nair, P., Kalanevich, P., Muesing, R., Ballard-Barbash, R., Taylor, P. and Bhagavan, H. Influence of fish oil and tocopherol supplements on plasma tocopherol and lipid levels. FASEB J. 4:2227, 1990.

Devereux-Graminski, B., Sampugna, J., Lanza, E., Ballard-Barbash, R., Nair, P.P. and Judd, J.T. Cheek cell lipids reflect dietary fish oil supplementation. FASEB J.4:2259, 1990.

Ferretti, A. and Flanagan, V.P. Modification of prostaglandin metabolism in vivo by long-chain omega-3 polyunsaturates. Biochimica et Biophysica Acta 1045:299-301, 1990.

Ferretti, A., Flanagan, V.P. and Maida, E.J. Measurement of the major metabolite or thromboxane B_2 in human urine. 7th Intl. Confer. on Prostaglandins and Related Compounds. Abstract book, page 372. 1990.

Finan, A., Nair, P.P., Bhagavan, H.N., Judd, J.T. and Ballard-Barbash, R. Effect of fish oil and vitamin E supplement on white blood cell glutathion-s-transferase activity in men. FASEB J. 4:3861, 1990.

Iyengar, V., Albaugh, G.P., Lohani, A., Gold, D. and Nair, P.P. Cytologic and immunochemical characterization of colonic cells isolated from human stools by density gradient. FASEB J. 4:5224, 1990.

Kim, Y.C., Bhathena, S.J., Nair, P.P., Bhagavan, H.N., Berlin, E., Judd, J.T. and Ballard-Barbash, R. Hormonal response to fish oil and vitamin E during oral glucose tolerance test in healthy males. FASEB J. 4:3858, 1990.

Loo, G., Berlin, E. and Allen, P. Effect of feed deprivation on hepatic membrane and lipoprotein fluidity on binding of lipoproteins to hepatic membranes in the chick (Gallus Domesticus). Comp. Biochem. Phyisol. 96B: 361-366, 1990.

Loo, G., Berlin, E. and Smith, J.T. Inhibition of mitochondrial palmitate oxidation by calmodulin antagonists. Intl. J. Biochem. 22:631-634, 1990.

Loo, G., Berlin, E. and Wong, H.Y.C. Effects of dietary n-3 and n-6 fatty acids on lipoprotein and hepatic membrane composition and fluidity in the hypercholesterolemic rabbit. FASEB J. 4:3076, 1990.

Loo, G., Wong, H.Y.C., Kliman, P.G., Berlin, E., Peters, R., Sherief, H.T., Zhuang, H. and Allen, P.C. Effect of dietary cholesterol on the lipoprotein profile and binding of radioiodinated lipoproteins to hepatic membranes in the cockerel (Gallus Domesticus). Comp. Biochem. Physiol., 97B:83-88, 1990.

Mangels, A.R., Morris, V.C., Nair, P.P., Bhagavan, H.N., Judd, J.T., Ballard-Barbash, R. and Levander, O.A. Rheological characteristics of red blood cells (RBC) from humans given fish oil and vitamin E. Tropical Medicine Meeting, 1990. ABSTRACT

Nair, P.P., Shami, S., Johnson, J.A. and Ausman, L.M. Fecal mutagen load in cancer-prone Cotton-top Tamarins (Sanguinus oedipus). FASEB J. 4:5282, 1990.

Nair, P.P., Shami, S., Sainz, E., Menon, M., Jerabek, L.B., Jones, D.Y., Judd, J.T., Campbell, W.S., Schiffman, M.H., Taylor, P.R., Schatzkin, A., Guidry, C. and Brown, C.C. Influence of dietary fat on fecal mutagenicity in premenopausal women. Intl. J. Cancer 46:374-377, 1990.

Norkus, E.P., Bhagavan, H.N. and Nair, P.P. Relationship between individual carotenoids in plasma, platelets and red blood cells (RBC) of adult subjects. FASEB J. 4:5270, 1990.

Sarafianos, S.G., Nair, P.P. and Kumar, S. AT^{32}P-Dependent estimation of nanomoles of fatty acids: its use in the assay of phospholipase assay of phospholipase A_2activity. Analytical Biochemistry 186:374-379, 1990.

Venkat, J., Plimmer, J.R., Nair, P.P. and Shami, S. A biological indicator for quantitative assessment of groundwater quality-some preliminary observation. American Chemical Society National Meeting, Boston, 1990. ABSTRACT

1991

Bhathena, S.J., Kim, Y.C., Law, J.S., Judd, J.T., Reichman, M.E., Taylor, P.R. and Schatzkin, A. Effect of moderate alcohol consumption on plasma opiate levels in premenopausal women. FASEB J. 5:A936. 1991.

Berlin, E., Judd, J.T., Nair, P.P., Jones, D.Y. and Taylor, P.R. Dietary fat and hormonal influences on lipoprotein fluidity and composition in premenopausal women. Artherosclerosis 86:95-110, 1991.

Berlin, E., Khan, M.A., Henderson, G.R. and Kliman, P.G. Dietary fat and cholesterol induced modification of minipig lipoprotein fluidity and composition. Comp. Biochem. Physiol. 98A:151-157, 1991.

Berlin, E., Shapiro, S.G. and Young, C. Relative effects of feeding saturated fats and cholesterol on fluidity of rabbit lipoproteins. Comp. Biochem. Physiol. 98A:343-346, 1991.

Bhathena, S.J., Berlin, E., Judd, J.T., Kim, Y.C., Law, J.S., Bhagavan, H.N., Ballard-Barbash, R. and Nair, P.P. Effects of ω3 fatty acids and vitamin E on hormones involved in carbohydrate and lipid metabolism in men. Am. J. Clin. Nutr. 54:684-688. 1991.

Church, J.P., Rao, D.D. and Judd, J.T. Effects of estradiol or fish oil on lipoprotein profiles in the rat. FASEB J. 5:A1304, 1991.

Clevidence, B. and Ballard-Barbash, R. Tocopherol contents of lipoproteins from frozen plasma separated by affinity chromatography. Lipids Vol. 26:723-728. 1991.

Di Nola, L., Taylorson, R.B. and Berlin, E. Thermotropic properties of cellular membranes in dormant and non-dormant *Echinochola crus-galli* (L.) Beauv. seeds. J. Exptl. Botany, Vol. 42, 234:113-121, 1991.

Ferretti, A., Judd, J.T., Ballard-Barbash, R., Nair, P.P., Taylor, P.R. and Clevidence, B. Endogenous synthesis of prostaglandin (PG) E in men during administration of an anchovy oil supplement. INFORM 2:337, ABSTRACT W5. 1991.

Ferretti, A., Judd, J.T., Ballard-Barbash, R., Nair, P., Taylor, P. and Clevidence, B. Effect of fish oil supplementation on the excretion of the major metabolite of prostaglandin E in healthy male subjects. Lipids. Vol. 26, 7:500-503, 1991.

Ferretti, A., Nelson, G.J. and Schmidt, P.C. Dietary-fish effect on the excretion of the urinary marker of PGE systemic turnover in healthy subjects. J. Am. Oil Chemists Soc. ABSTRACT W4. 1991.

Ferretti, A., Nelson, G.J. and Schmidt, P.C. A salmon-rich diet inhibits arachidonate cyclooxygenation in healthy men. J. Nutr. Biochem. 2:547-552. 1991.

Ferretti, A. and Judd, J.T. PGE_1 compared to $PGE_2/PGF_{2\alpha}$ ratio as a marker for seminal fluid contamination of urine in studies of renal prostaglandin biosynthesis. Prostaglandins, Leukotrienes and Essential Fatty Acids. 44:47-50, 1991.

Iyengar V., Albaugh, G.P., Lohani, A. and Nair, P.P. Human stools as a source of viable colonic epithelial cells. FASEB J. 5:2856-2859. 1991.

Kramer, T.R., Schoene, N., Douglass, L.W., Judd, J.T., Ballard-Barbash, R., Taylor, P.R., Bhagavan, H.N. and Nair, P.P. Increased vitamin E intake restores fish oil induced suppressed blastogenesis of mitogen stimulated t-lymphocytes. Am. J. Clin. Nutr. 54:896-902. 1991.

Law, J.S. Bhathena, S.J., Kim, Y.C., Berlin, E., Judd, J.T., Reichman, M.E., Taylor, P.R. and Schatzkin, A. Effect of alcohol consumption on hormones involved in carbohydrate and lipid metabolism in premenopausal women. FASEB J. 5:A936. 1991.

Loo, G. and Berlin, E. Benzyl alcohol increases binding of human lipoproteins to rat liver plasma membrane. FASEB J. 5:A946. 1991.

Loo, G., Berlin, E., Peters, R., Kliman, P. and Wong, H.Y.C. Effect of dietary corn, coconut, and menhaden oils on lipoprotein, liver, and heart membrane composition in the hypercholesterolemic rabbit. J. Nutr. Biochem. 2:594-603. 1991.

Mertz, W., Tsui, J.C., Judd, J.T., Reiser, S., Hallfrisch, J., Morris, E.R., Steele, P. and Lashley, E. What are people really eating? The relation between diet records and intakes to maintain body weight. Am. J. Clin. Nutr. 54:291-295. 1991.

Nair, P.P. Bile Acids. In Encyclopedia of Human Biology Academic Press, 1:623-626, 1991.

Nair, P.P., Shami, S., Sainz, E., Judd, J.T., Taylor, P.R. and Schatzkin, A. Quantitative assessment of the genotoxicity of fecapentaenes. Mutation Research 260:153-157, 1991.

Schoene, N. Dietary fatty acids and platelet function: Mechanisms. In: Health Effects of Dietary Fatty Acids. G. Nelson (ed) AOCS, Champaign, IL, pp. 129-135. 1991.

Schoene, N.W. and Church, J.P. Differential effects of dietary fats on aggregration of platelets from rats. Nutrition Research 11:479-489, 1991.

Schoene, N. and Podczasy, J. Dietary n-3 fatty acids and their effect on apparent mean volume of rat platelets. FASEB J. 5:A1302. 1991.

Vanderhoek, J.Y., Schoene, N.W. and Pham, P.P.T. The inhibitory potencies of fish oil hydroxy fatty acids on cellular lipoxygenases and platelet aggregration. Biochem. Pharmacol. 42:959-962. 1991.

Nutrient Composition Laboratory
Beltsville Human Nutrition Research Center
Beltsville, Maryland 20705

Mission: The mission of the laboratory is to identify critical needs relative to the nutrient content of foods and to conduct research to meet these needs. To accomplish this mission, the research goals of the laboratory are: (1) to design and develop new and/or improved measurement systems for the analysis of nutrients and important other constituents in foods by conducting appropriate research in chemistry, biochemistry and biology, (2) to develop and utilize sound sampling techniques for the U.S. food supply to ensure that representative samples are analyzed for their nutrient content, (3) to transfer new technologies to industrial, academic and government laboratories both in the United States and world wide, (4) to analyze the nutrient content of foods with tested dependable assay techniques and supply results of these analyses to appropriate groups and agencies.

Dr. Gary R. Beecher
Research Leader
Supervisory Research Chemist
Room 102, Building 161
Beltsville, Maryland 20705
301/504-8356

Coordinates research activities of the laboratory with research in other organizations including other USDA laboratories, NIH, FDA, universities and international organizations. Develops methodologies and measurement systems for the quantification of carotenoids and other phytochemicals in foods and diets that may be associated with nutritionally related disorders.

Dr. James M. Harnly
Research Chemist
Room 2, Building 161
Beltsville, Maryland 20705
301/504-8569

Develops multielement atomic absorption and emission instrumentation and methods for the determination of trace metals in micro samples. Employs graphite furnace atomizers, double furnace atomizers, solid state array detectors, high intensity xenen arc lamps, and glow discharges in developing new instrumental approaches.

Joanne M. Holden
Nutritionist
Room 103, Building 161
Beltsville, Maryland 20705
301/504-8186

Designs, develops, and implements statistically based sampling strategies which serve as the basis for selection of food samples to be analyzed. Develops expert systems for the evaluation of nutrient composition data. Serves on an international committee concerning the development of standardized food description. Coordinates food sample preparation and the dissemination of nutrient composition data.

Frederick Khachik
Research Chemist
(Research associate with Dr. Beecher)
Room 104, Building 161
Beltsville, MD 20705
301/504-8830

Isolates and elucidates the chemical structure of carotenoids in fruits, vegetables, and human plasma by various spectroscopic techniques and organic synthesis. Develops liquid chromatographic techniques for purification, separation, and quantification of a broad spectrum of carotenoids from natural products and human plasma.

Dr. Betty W. Li
Research Chemist
Room 105, Building 161
Beltsville, Maryland 20705
301/504-8466

Develops accurate, high volume methods for carbohydrate analyses; especially sugars and starch determinations using gas-liquid and high-performance liquid chromatographic techniques. Develops reliable methods for the analysis of total dietary fiber by simplifying existing enzymatic/gravimetric procedures. Serves as an associate referee for total dietary fiber methods. Improving conditions for hydrolysis of polysaccharides, using microwave digestion system.

Dr. Nancy J. Miller-Ihli
Research Chemist
Room 1, Building 161
Beltsville, Maryland 20705
301/504-8252

Develops methods and instrumentation for trace element determinations focusing on atomic spectroscopic techniques. Utilizes graphite furnace atomic absorption spectrometry (GFAAS) to perform direct analysis of solid samples prepared as slurries. Develops sample preparation and presentation procedures for trace metal analysis of biological materials. Develops and characterizes food quality control materials. Participates in the evaluation of analytical capabilities of commercial laboratories.

Dr. Raymond H. Thompson, Jr.
Research Chemist
Room 203B, Building 161
Beltsville, Maryland 20705
301/504-8789

Development of improved methods to quantify lipids and lipid components in foods. Determination of fatty acids, cholesterol, plant sterols, and tocopherols using capillary gas-liquid chromatography (GLC). Application of multidimensional, capillary GLC (tandem column configurations with "valveless" stream splitting) for methods development in the quantification of cis-trans geometric and positional isomers of fatty acids. Development of improved lipid extraction methods.

Linda H. Tonucci
Research Chemist
(Post Doc with Dr. Beecher)
Room 104, Building 161
Beltsville, MD 20705
301/504-8830

Develops methods using supercritical fluids to extract carotenoids from fruits, vegetables, and high fat foods. Investigates the qualitative and quantitative distribution of carotenoids in fruits and vegetables from a number of South Pacific Islands. Recent epidemiological studies have demonstrated a significant reduction in the incidence of several types of cancers among the populations of these Island Nations. In addition, identifies and quantifies carotenoids in tomato based products commonly consumed in the United States. These much needed data will be used in nutrient composition tables.

Dr. Joseph T. Vanderslice
Research Chemist
Room 202B, Building 161
Beltsville, Maryland 20705
301/504-9370

Determines vitamins in food and food extracts by high performance liquid chromatography; special emphasis is placed on developing extraction procedures which yield full vitamin recovery without destruction of any vitamin forms and which separate the vitamins from possible interfering compounds. Of particular interest at present are vitamin C and folacin.

Dr. Wayne R. Wolf
Research Chemist
Room 4, Building 161
Beltsville, Maryland 20705
301/504-8927

Conducts research and coordinates joint programs with National Institute of Standards and other agencies for development of nutrient/food related Standard Reference Materials. Develops methodology and applications for determination of chemical species and bioavailability of trace elements utilizing chromatographic and microbiological techniques.

RECENT RESEARCH ACCOMPLISHMENTS

Nonenzymatic-gravimetric Method for Total Dietary Fiber Analysis

Most gravimetric methods for total dietary fiber (TDF) determination require the complete removal of starch and the partial removal of protein with various combination of enzymes in buffers at different pH and at temperatures much above ambient condition. An enzymatic hydrolysis step is crucial in dietary fiber analysis of samples; such as cereals and legumes that contain appreciable amounts of starch. However, many vegetables and most fruits contain very little or no starch, and they are often eaten uncooked. It would be unnecessary to use high temperatures and enzymes on these types of samples. We were able to show that suspending the freeze-dried and ground samples in deionized water for 90 minutes at 37^{o}C followed by the addition of 95% ethanol yields TDF values similar to those obtained from other published methods. An AOAC collaborative study is currently underway, results should be available for publication by November 1992.

New Method for Vitamin C Analysis

A procedure for quantifying Vitamin C in foods and biological materials has been developed and successfully applied to a large variety of samples. The method distinguishes between compounds that exhibit vitamin activity and their isomers which have little or no activity. Since the latter are often used as antioxidants in foods, the method should prove useful for monitoring required by the new mandated labeling laws.

New Source for Atomic Absorption Spectrometry

Developed a continuum source atomic absorption detection system with detection limits comparable to commercial instruments, but, with the potential for multielement determinations. Continuum sources offer light at all wavelengths for multielement determinations, but, are noisy and weak in the far UV (300 nm). By using a diode array detector, covering a small wavelength region around the absorption line, and pulsing the continuum source, detection limits are dramatically improved. Multielement determinations can be made by using multiple arrays in the focal planes.

New Atomic Emission Source

Established a low voltage arc inside a graphite furnace making the furnace an efficient multielement atomic emission source. Graphite furnaces are efficient atomizers, but do not furnish sufficient thermal energy to make sensitive emission sources. The low voltage arc is used for electrical excitation of the analyte atoms and produces electron excitation temperatures from 3000 to 4000^{o}C. The result is an intense emission source with detection limits which are comparable to or better than graphite furnace atomic absorption, but, is readily adaptable to multielement determinations.

Slurry Sampling for Graphite Furnace Atomic Absorption Spectrometry

The preparation of samples for analysis by atomic absorption spectrometry requires the use of strong acids and oxidizing agents. This is a long procedure and sample contamination is a concern. A method and associated instrumentation was developed whereby solid samples prepared as slurries, may be analyzed directly by graphite

furnace atomic absorption spectrometry (GFAAS). Slurries are prepared by diluting a small amount (5-50mg) of finely ground material with dilute acid and dispersing agent. Mixing is accomplished using an ultrasonic probe and this technology has been patented. Perkin-Elmer was granted an exclusive license and is currently marketing an autosampler accessory for slurry GFAAS Analyses. A wide variety of materials have been successfully determined using this approach which is especially well suited for environmental and health monitoring and product control.

Microbiological Assay for Chemical Species of Selenium

This assay takes advantage of the presence in the bacteria Escherichia coli of formate dehydrogenase (FDH) enzymes that require selenium for synthesis. These FDH enzymes catalyze the formation of CO_2 from formic acid, a sugar metabolite. By measuring CO_2 production with a Bactec Infrared Analyzer we have developed a microbiological assay with linear dose response curves extending over several orders of magnitude down to the picomoles/ml range for selenomethionine and selenite. We are approaching the problem of determining chemical species by use of mutant strains of E. coli and the differential response of FDH enzymes to anaerobic and aerobic growth conditions.

Development of a Carotenoids Database for the Assessment of Carotenoids Intake

The consumption of several fruits and vegetables has been inversely associated with the incidence of specific cancers in humans. Scientific investigation of these relationships require high quality composition data for the important contributors of dietary carotenoids. An expert system has been developed to evaluate the quality of published values for five carotenoids in 120 fruits and vegetables. Acceptable data have been combined with recipe formulations in the USDA National Nutrient Data Bank Recipe File to produce a database of approximately 2300 simple and complex foods with values for five carotenoids, alpha-carotene, beta-carotene, lutein, lycopene and beta-cryptoxanthin.

Simplified Methods for Cholesterol Analysis

Developed a simplified procedure for quantitative analysis of cholesterol in fluid milk products. Also conducted research leading to an updating and simplification of the AOAC method for determination of cholesterol in multicomponent foods.

New Total Diet Standard Reference Material for Nutrient Determinations

Standard Reference Material (SRM) 1548 Total Diet was developed for use in evaluating the reliability of analytical methods used for the determination of nutrient constituents related to health and disease in mixed diets, individual foods and biological matrices. This freeze dried powder material was prepared from excess foods obtained from the U.S. Food and Drug Administration's Total Diet Study (FDA-TDS) and was composited to be representative of an adult diet in the United States. The Certificate of Analysis for SRM 1548 provides certified concentrations and uncertainties for fourteen elements (N, Cl, Na, K, P,S, Ca, Mg, Fe, Zn, Mn, Cu, Se and Cd) in addition to values for fat, ash, Kjeldahl N, dietary fiber, cholesterol and energy content. The SRM 1548 is available through the Standard Reference Materials Programs, National Institute of Standards and Technology, Gaithersburg, Maryland.

PUBLICATIONS

1989

Beecher, G.R., Matthews, R.H. Current Knowledge of Food Composition in the United States. Family and Community Health 12:33-41, 1989.

Brown, E.D., Micozzi, M.S., Bieri, J.G., Beecher, G.R., Edwards, B., Rose, A., Smith, J.C. Changes in Plasma Carotenoids in Normal Men after a Single Ingestion of Vegetables or Pure *b*-Carotene. Am. J. Clin. Nutr. 49:1258-1265, 1989.

Douglass, F.D., Morrow, K. Ono, Keeton, J.T., Vanderslice, J.T., Post, R.C., Willis, B.W. Impact of Sodium Ascorbate and Sodium Erythorbate Used in Meat Processing on the Vitamin B12 Contents of Cured Ham. J. Food Sci. 54(6):1473-1474, 1989.

Epstein, M.S., Carnrick, G.R., Slavin, W., Miller-Ihli, N.J. Automated Slurry Sample Introduction for Analysis of a River Sediment by Graphite Furnace Atomic Absorption Spectrometry. Anal. Chem. 61:1414-1419, 1989.

Epstein, M.S., Miller-Ihli, N.J., Carnrick, G.R. Homogeneity Evaluation of Reference Materials Using Slurry Sampling for GFAAS. 72nd Canadian Chemical Conference and Exhibition, Victoria, BC, June 1989.

Goli, D.M., Vanderslice, J.T. Microbiological Assays of Folacin Using a CO_2 Analyzer System. J. Micronut. Anal. 6:19-23, 1989.

Harnly, J.M., Moulton, G.P., O'Haver, T.C. Continuum Source AAS with a Pulsed Source and a Photodiode Array Detector. Rocky Mountain Conference on Analytical Chemistry, Denver, Co, August 1989.

Harnly, J.M., Styris, D.L., Ballou, N.E. Hollow Anode Discharge - Carbon Furnace Atomic Emission. Pittsburgh Conference and Exhibition, Atlanta, GA, March 1989.

Harnly, J.M., Styris, D.L., Ballou, N.E. Hollow Anode Discharge - Graphite Furnace Emission Spectrometry. Rocky Mountain Conference on Analytical Chemistry, Denver, CO, August 1989.

Higgs, D.J., Vanderslice, J.T. Total Vitamin C as Determined by Flow Injection Analysis and Standard AOAC Methods. Pittsburgh Conference, Atlanta, GA, March 1989.

Holden, J.M., Exler, J., McCharen, C., Lochard, J.A. Nationwide Study of the Cholesterol, Proximate, Vitamin and Mineral Levels in Large Eggs. FASEB J. 3:A658, 1989.

Ihnat, M., Wolf, W.R. The Literature of Selenium and the Status and Treatment of Analytical Data. In: Occurrence and Distribution of Selenium. M. Ihnat, ed., CRC Press, pp. 25-32, 1989.

Khachik, F., Beecher, G.R. Goli, M.B., Lusby, W.R., Hankin, J.H. Separation, Identification and Quantification of Carotenoids and Carotenol Fatty Acid Esters in Common Fruits and Vegetables from The Cook Islands. 198th American Chemical Society National Meeting, Miami Beach, FL, September 1989.

Khachik, F., Beecher, G.R., Lusby, W.R. Separation, Identification and Quantification of the Major Carotenoids in Extracts of Apricots, Peaches, Cantaloupe and Pink Grapefruit by Liquid Chromatography. J. Agric. Food Chem. 37:1465-1473, 1989.

Khachik, F. Goli, M.B., Beecher, G.R., Holden, J.M., Lusby, W.R., Tenorio, M.D., Barrera, M.R. The Effect of Food Preparation on Qualitative and Quantitative Distribution of Major Carotenoid Constituents of Several Green Vegetables. 198th American Chemical Society National Meeting, Miami Beach, FL, September 1989.

Li, B.W. Simplified Method for the Determination of Total Dietary Fiber and its Soluble and Insoluble Fractions. Symposium on Dietary Fiber--New Developments: Analytical Method. 197th American Chemical Society National Meeting, Dallas, TX, April 1989.

Miller-Ihli, N.J. An Automated Ultrasonic Mixing Accessory for Slurry Graphite Furnace Atomic Absorption Spectrometry. J. Anal. At. Spectrom. 4:295-297, 1989.

Miller-Ihli, N.J. Graphite Furnace Atomic Absorption Spectrometry for the Analysis of Biological Materials, Spectrochimica Acta Part B, 12:1221-1227, 1989.

Miller-Ihli, N.J. In-House Biological Trace Element Quality Control Materials. Sci. Total Environ. 89:361-364, 1989.

Miller-Ihli, N.J. Characterization of an Ultrasonic Agitation Device for Slurry Mixing, Pittsburgh Conference, Atlanta, GA, March 1989.

Miller-Ihli, N.J. Slurry Sample Preparation for Graphite Furnace Atomic Absorption Spectrometry. 72nd Canadian Chemical Conference & Exhibition, Victoria, BC, June 1989.

Miller-Ihli, N.J. Slurry Sample Preparation for the Determination of Trace Metals. Federation of Analytical Chemistry and Spectroscopy Societies, Chicago, IL, October 1989.

Miller-Ihli, N.J. GFAAS for the Determination of Trace Metals in Biological Materials. Federation of Analytical Chemistry and Spectroscopy Societies, Chicago, IL, October 1989.

Miller-Ihli, N.J. Slurry Sampling for Trace Metal Determinations in Biological Materials. 1989 International Chemical Congress of Pacific Basin Societies, Honolulu, HI, December 1989.

Moulton, G.R., O'Haver, T.C., Harnly, J.M. Continuum Source AAS with a Pulsed Light Source and Diode Array Detector. Pittsburgh Conference, Atlanta, GA, March 1989.

Moulton, G.P., O'Haver, T.C., Harnly, J.M. Continuum Source Atomic Absorption Spectrometry with a Pulsed Source and A Photodiode Array Detector. J. Anal. At. Spectrom. 4:673, 1989.

Scurra, L., Wolf, W.R., Rand, W. Comparison of Six Nutrient Databases within USDA. Proceedings of the 13th Nutrient Data Bank Conference, pp. 125-145, 1989.

Styris, D.L., Ballou, N.E., Harnly, J.M. A Graphite Furnace Hollow Anode Glow-Discharge Excitation Source. 72nd Canadian Chemical Congress and Exhibition, Victoria, BC, Canada, June 1989.

Vanderslice, J.T. and Higgs, D.J. Automated Analysis of Total Vitamin C in Foods. J. Micronutr. Anal. 6:109-117, 1989.
Vanderslice, J.T., Higgs, D.J. Total Vitamin C as Determined by Flow Injection Analysis and Standard AOAC Methods. Pittsburgh Conference, Atlanta, GA, March 1989.

Vanderslice, J.T., Higgs, D.J. An Automated Robotic Extraction Procedure for the Flow Injection Analysis of Total Vitamin C in Foods. Pittsburgh Conference, Atlanta, GA, March 1989.

Wolf, W.R. Guest Editorial on Biological Reference Materials. American Laboratory, April 1989.

Wolf, W.R., Iyengar, V., Tanner, J.T. Mixed Diet Reference Materials for Nutrient Analysis. International Conference on Nuclear Methods in the Life Sciences, April 1989.

Wolf, W.R., Schubert, A. Foods-Chapter 6. In: Occurrence and Distribution of Selenium. M. Ihnat, ed., CRC Press, pp. 107-120, 1989.

Patents

Harnly, J.M., Moulton, G.P., O'Haver, T.C. A Pulsed Continuum - Diode Array Detector Multielement Atomic Absorption Spectrometer. U.S. Patent Pending.

1990

Anderson, E., Angyl, G., Weaver, C.M., Felkner, I.C., Worthy, B.E. and Wolf, W.R. Laser/Microbe Bioassay System for the Determination of Water Soluble Vitamins. AOAC Meeting, New Orleans, LA, September 1990. (Abstract)

Beecher, G.R. and Matthews, R.H. Nutrient Composition in the United States. In: Present Knowledge in Nutrition. M.L. Brown (Ed), International Life Sciences Institute - Nutrition Foundation, Washington, DC, 1990.

Beecher, G.R., Holden, J.M., Wolf, W.R., Ershow, A. and Dennis, B. Mixed Diet Quality Control Material for Fat, Fatty Acid, and Cholesterol Analysis. Fourth International Symposium on Biological and Environmental Reference Materials, Orlando, Fl, February 1990. (Abstract)

Goli, D.M., DeSouza, S.C. and Vanderslice, J.T. Investigation of the Enzyme Treatment Procedure in the Microbiological Assay of Folacin. 200th American Chemical Society Meeting, Washington, DC, August 1990. (Abstract).

Goli, M.B., Khachik, F., Beecher, G.R. and Lusby, W.R. Separation of Oxygenated Carotenoids on a Silica-Based Nitrile Bonded Column by HPLC. 200th American Chemical Society Meeting, Washington, DC, August 1990. (Abstract)

Harnly, J.M., Styris, D.L. and Ballou, N.E. A Hollow Anode Discharge-Graphite Furnace Emission Source. J. Anal. At. Spectrom., 5, 139 (1990).

Harnly, J.M., Styris, D.L. and Ballou, N.E. Furnace Atomic Non-thermal Excitation Spectrometry with the Furnace as a Hollow Anode. J. Anal. At. Spectrom. 5, 139-144 (1990).

Harnly, J.M. Use of Fourier Transforms to Discern Peak Shape Differences Between Standards and Samples. Pittsburgh Conference, New York, NY, March 1990. (Abstract)

Harnly, J.M., Styris, D.L. and Ballou, N.E. Hollow Anode Discharge-Graphite Furnace Atomic Emission Spectrometry. Pittsburgh Conference, New York, NY, March 1990. (Abstract)

Harnly, J.M. The Multielement Graphite Furnace Atomic Spectrometry, the Search for Photons in the UV. BNASS Meeting, University of Loughborough, United Kingdom, July 1990. (Abstract)

Harnly, J.M. A Pulsed Xenon Arc Lamp and a Linear Photodiode Array for Continuum Source Atomic Absorption Spectrometry. Analyliktreffin 1990 East German Conference on Analytical Spectroscopy, Neubrandenburg, GDR, July 1990. (Abstract)

Harnly, J.M. Optimum Spectrometer Parameters for Detector Noise Limited Atomic Absorption Spectrometry. FACSS Meeting, Chicago, IL, October 9-12, 1990. (Abstract)

Holden, J.M. and Davis, C.S. Use of Cholesterol Reference Materials in a Nationwide Study of the Cholesterol Content of Eggs. Frezenius J. Analyt. Chemie. 338, 476-478 (1990).

Holden, J.M. Use of Cholesterol Reference Materials in a Nationwide Study of the Cholesterol Content of Eggs. Fourth International Symposium on Biological and Environmental Reference Materials, Orlando, FL, February 1990. (Abstract)

Holden, J.M. Gebhardt, S., Davis, C.S. and Lurie, D.G. A Nationwide Study of the Selenium Levels and Availability in Bread Products. 74th FASEB Meeting, Washington, DC, April 1990. (Abstract)

Holden, J.M. SELEX: An Expert System for the Assessment of Selenium Data Quality. Sixth Annual Scientific Computing and Automation Conference and Exposition, Philadelphia, PA, September 1990. (Abstract)

Khachik, F., Beecher, G.R., Goli, M.B. and Lusby, W.R. Separation, Identification, and Quantification of Carotenoids in Fruits and Vegetables by High Performance Liquid Chromatography. Ninth International Symposium on Carotenoids, Kyoto, Japan, May 1990. (Abstract)

Khachik, F., Beecher, G.R., Goli, M.B. and Lusby, W.R. Separation, Structural Elucidation and Quantification of New Carotenoids in Human Plasma by High Performance Liquid Chromatography. Ninth International Symposium on Carotenoids, Kyoto, Japan, May 1990. (Abstract)

LaCroix, D.E., Wolf, W.R. and Slagt, M.E. Determination of Seleno- Methionine by Ion Exchange HPLC. 199th American Chemical Society Meeting, Boston, MA, April 1990. (Abstract)

Li, B.W. and Cardozo, M.S. Simplified Method for the Determination of Total Dietary Fiber and its Soluble and Insoluble Fractions in Foods. In: New Developments in Dietary Fiber: Physiological, Physicochemical, and Analytical Aspects. I. Furda and C.J. Brine, Eds., Plenum Publishing Corporation, New York, pages 283-293, 1990.

Li, B.W. Dietary Fiber Analysis: Comparison of Methods and Impact. In: Emerging Issues in Food Science and Technology - 1990. Southern California Food Industry Conference, Orange, CA, January 1990. (Abstract)

Micozzi, M.S, Beecher, G.R., Taylor, P.R. and Khachik, F. Carotenoid Analyses of Selected Raw and Cooked Foods Associated with a Lower Risk for Cancer. J. of the Natl. Cancer Inst. 82(4), (1990).

Miller-Ihli, N.J. Determination of Metals in Biological Samples Using Slurry Sampling Graphite Furnace Atomic Absorption Spoectrometry. FACSS Meeting, Chicago, IL, October 9-12, 1990. (Abstract)

Miller-Ihli, N.J. Simultaneous Multielement Atomic Absorption Analysis of Biological Materials. Talanta 37, 119-125 (1990).

Miller-Ihli, N.J. Preparation, Characterization, and Use of Food Quality Control Materials. Fourth International Symposium on Biological and Environmental Reference Materials, Orlando, FL, February 1990. (Abstract)

Miller-Ihli, N.J. and Epstein, M.S. Slurry Graphite Furnace Atomic Absorption Determinations for Material Homogeneity Assessment. Fourth International Symposium on Biological and Environmental Reference Materials, Orlando, Fl, February 1990. (Abstract)

Miller-Ihli, N.J. Slurry GFAAS Analyses of Biological Materials. Canadian Chemical Conference, Halifax, NS, July 1990. (Abstract)

Miller-Ihli, N.J. A Method for Evaluating Collaborating Laboratories. Presented at 1990 AOAC Meeting, New Orleans, LA, September 1990. (Abstract).

Miller-Ihli, N.J. A Novel Approach to Solid Sampling Using GFAAS. 36th Canadian Spectroscopy Conference, St. Catherines, Ontario, Canada, August 1990. (Abstract)

Miller-Ihli, N.J. Slurry Sampling for Graphite Furnace Atomic Absorption Spectrometry. Frezenius Z. Analyt. Chemie. 337, 271-274 (1990).

Miller-Ihli, N.J. Processing and Apparatus for Direct Ultrasonic Mixing Prior to Analysis. U.S. Patent 4,930,898 issued June 5, 1990

Moulton, G.P., O'Haver, T.C. and Harnly, J.M. Continuum Source AAS with a Pulsed Light Source and Diode Array Detector. Pittsburgh Conference, New York, NY, March 1990. (Abstract)

Moulton, G.P., O'Haver, T.C. and Harnly, J.M. Signal to Noise Ratios for Continuum Source Atomic Absorption Spectrometry Using a Linear Photodiode Array to Monitor Sub-nanometre Wavelength Intervals. J. Anal. Atomic Spect. 5:145-150 (1990).

Moulton, G.P., O'Haver, T.C. and Harnly, J.M. Graphite Furnace AAS with a High Current Pulsed Continuum Source and a Linear Photodiode Array Detector. FACSS Meeting, Chicago, IL, October 9-12, 1990. (Abstract)

Moulton, G.P., O'Haver, T.C. and Harnly, J.M. Electrothermal AAS with a Pulsed Xenon Arc Source and Photodiode Array Detection. BNASS Meeting, University of Loughborough, United Kingdom, July 1990. (Abstract)

Riby, P.G. and Harnly, J.M. The Determination of As, Cd, Cu, and Cr by Hollow Anode Furnace Atomization Non-Thermal Excitation Spectroscopy. FACSS Meeting, Chicago, IL, October 9-12, 1990. (Abstract)

Riby, P.G., Harnly, J.M. and Styris, D.L. Excitation Characteristics in a Hollow Anode FANES System. FACSS Meeting, Chicago, IL, October 9-12, 1990. (Abstract)

Riby, P.G., Harnly, J.M. and Styris, D. Hollow Anode Discharge- Graphite Furnace Atomic Emission Spectrometry-Initial Investigations. BNAAS Meeting, University of Loughborough, United Kingdom, July 1990. (Abstract)

Riby, P.G., Harnly, J.M. and Styris, D. Instrumental Conditions and Background Emission in Hollow Anode Discharge-Graphite Furnace Atomic Emission Spectrometry. Research and Development Topics Meetings, Runcon, United Kingdom, July 1990. (Abstract)

Russell, L.F. and Vanderslice, J.T. A Comprehensive Review of Vitamin B_2 Analytical Methodology. J. Micronutr. Anal. 8:257-310 (1990).

Schakel, S., Holden, J.M., Miller-Ihli, N.J., Davis, C.S. and Buzzard, I.M. Quantification of Fat and Sodium Retention in Common Meat Preparation Methods. Proceedings of the Fifteenth Annual Nutrient Databank Conference, Blacksburg, VA, June 1990.

Tanner, J.T., Iyengar, G.V. and Wolf, W.R. Organic Nutrient Content of the U.S. Food and Drug Administration Total Diet and its Possible Use as a Standard Reference Material. Frezenius J. Analyt. Chemie. 338, 438-440 (1990).

Vanderslice, J.T., Higgs, D.J. Hayes, J.M. and Block, G. Ascorbic Acid and Dehydroascorbic Acid Content of "Foods-as-Eaten". J. Food Comp. Anal. 3, 105-118 (1990).

Vanderslice, J.T. and Higgs, D.J. An Improved Chromographic Separation of Ascorbic Acid, Dehydroascorbic Acid and their Isomers. J. Micronutr. Anal. 7, 67-70 (1990).

Vanderslice, J.T. and Higgs, D.J. Representative Values of the Forms of Vitamin C in Foods – Influences of Extraction Methodology and Sample Variability. FASEB Meeting, Washington, DC, April 1990. (Abstract)

Vanderslice, J.T. and Higgs, D.J. Ascorbic Acid, Dehydroascorbic Acid and total Vitamin C in Foods: Implications for Diet Studies and Plasma Level Determinations. Symposium on Ascorbic Acid: Biological Functions and Relations to Cancer, Bethesda, MD, September 1990. (Abstract)

Vanderslice, J.T. and Higgs, D.J. Separation of Ascorbic Acid, Isoascorbic Acid, Dehydroascorbic Acid and Dehyodroisoascorbic Acid in Food and Animal Tissue. J. Micronutr. Anal. 7:67-70 (1990).

Vanderslice, J.T., Higgs, D.J., Hayes, J.M. and Block, G. Ascorbic Acid and Dehydroascorbic Acid Content of Foods-as-Eaten. J. Food Comp. Anal. 3:105-118 (1990).

Wolf, W.R. Certificate of Analysis Standard Reference Material 1548 Total Diet. Standard Reference Materials Program, National Institute of Standards and Technology, Gaithersburg, MD, September 1990.

Wolf, W.R. and Stoeppler, M. Eds., Proceedings of Fourth International Symposium on Biological and Environmental Reference Materials. Special Issue Frezenius J. Analyt. Chemie. Vol. 338, 359-582, 1990.

Wolf, W.R. Evaluation and Improvement of Nutrient Composition Data for Trace Elements in Foods. In: ACS Symposium Series #495, Title: Biological Trace Element Research Multidisciplinary Perspectus, ACS, Washington, DC, pp. 107-112, 1990.

Wolf, W.R., Iyenger, G.V. and Tanner, J.T. Mixed Diet Reference Materials for Nutrient Analysis of Foods: Preparation of SRM-1548 Diet. Frezenius J. of Analyt. Chemie. 338, 473-475, 1990.

Wolf, W.R. Reference Materials for Analysis of Foods for Nutrient Content. FASEB Meeting, Washington, DC, April 1990. (Abstract)

Zainal, H., Wolf, W.R. and Khana, R. Potentiometric and Spectroscopic Studies of Metal Complexes with Selenomethionine. 200th Annual Meeting of the American Chemical Society, Washington, DC, August 1990. (Abstract)

1991

Beecher, G. R., Khachik, F., Goli, M. B., Hankin, J., and Lemarchand, L. Carotenoids in Foods Commonly Consumed by South Pacific Islanders. Presented at XVII Pacific Science Conference, Honolulu, Hawaii, May 1991. (Abstract)

Beecher, G. R., Khachik, F., Goli, D. M., Holden, J. M., and Lusby, W. R. Recent Advances in the Analysis of Carotenoids in Foods. Presented at Fifth Conference for Federally Supported Human Nutrition Research, Bethesda, Maryland, April 1991. (Abstract)

Beecher, G. R., Khachik, F., Goli, M. B., and Lusby, W. R. Separation and Identification of Minor Carotenoid Components in Human Plasma. Presented at Fifth Conference for Federally Supported Human Nutrition Research, Bethesda, Maryland, April 1991. (Abstract)

Beecher, G. R. Overview of Research Activity on Development of Measurement Systems for Nutrients in Foods. Presented at Fifth Conference for Federally Supported Human Nutrition Research, Bethesda, Maryland, April 1991. (Abstract)

Beecher, G. R., Khachik, F., Goli, M. B., and Lusby, W. R. Separation and Quantification of Carotenoids in Human Plasma on Nitrile Bonded and Reversed Phase HPLC Columns. Presented at Federation of American Societies for Experimental Biology Meeting, Atlanta, Georgia, April 1991. (Abstract)

Cardozo, M. S., Camara, M., and Li, B. W. Effects of Cooking and Freeze-Drying on Dietary Fiber Content of Broccoli, Chinese Cabbage and Spanish Onion. Presented at Institute of Food Technologies Annual Meeting, Dallas, Texas, June 1991. (Abstract)

Goli, D. M., and Vanderslice, J. T. Investigation of Microbiological Assay for Folate Using Synthetic Standards. Presented at Fifth Conference for Federally Supported Human Nutrition Research, Bethesda, Maryland, April 1991. (Abstract)

Harnly, J. M., Moulton, G. P., and O'Haver, T. C. Continuum Source Atomic Absorption Spectrometry. Patent No. 5,018,856. May 28, 1991.

Harnly, J. M. Graphite Furnace Continuum Source-Atomic Absorption Spectrometry with Diode Array Detection. Presented at XXVII Colloquium Spectroscopicum Internationale, Lofthus, Norway, June 1991. (Abstract)

Harnly, J. M. Continuum Source AAS with a Photodiode Array Detector. Presented at XXVII Colloquium Spectroscopicum Internationale, Bergen, Norway, June 1991. (Abstract)

Harnly, J. M. Advances in Continuum Source-Atomic Absorption Spectrometry. Presented at 37th Canadian Spectroscopy Conference, Ottawa, Canada, August 1991. (Abstract)

Harnly, J. M., and Riby, P. G. Trace Element Determinations by Hollow Anode-Furnace Atomisation Non-Thermal Excitation Spectrometry (HA-FANES). Presented at 37th Canadian Spectroscopy Conference, Ottawa, Canada, August 1991. (Abstract)

Harnly, J. M. Increasing the Spectral Band-Pass to Improve the Signal-to-Noise Ratio for Continuum Source-Atomic Absorption Sectrometry with a Photodiode Array Detector. Presented at the Federation of Analytical Chemistry & Spectroscopy Societies, Anaheim, California, October, 1991. (Abstract)

Harnly, J. M. Gated Detection to Eliminate Flicker Noise for Continuum Source-Atomic Absorption Secterometry with a Photodiode Array Detector. Presented at the Federation of Analytical Chemistry & Spectroscopy Societies, Anaheim, California, October 1991. (Abstract)

Harnly, J. M. Continuum Source AAS with Detection Limits Comparable to Conventional AAS at Wavelengths Below 280 nm. Presented at the Federation of Analytical Chemistry & Spectroscopy Societies, Anaheim, California, October 1991. (Abstract)

Holden, J. M., Mangels, A. R., Moorehead, M., and Davis, C. S. The Evaluation of Nutrient Composition Data Quality: An Artificial Intelligence Approach. Presented at Fifth Conference for Federally Supported Human Nutrition Research, Bethesda, Maryland, April 1991. (Abstract)

Holden, J. M., Mangels, A. R., Beecher, G. R., Forman, M., and Lanza, E. The Critical Evaluation of Values of Carotenoids for Foods. Presented at Federation of American Societies for Experimental Biology Meeting, Atlanta, Georgia, April 1991. (Abstract)

Khachik, F., Beecher, G. R., Goli, M. B. and Lusby, W. R. Separation, Identification and Quantification of Carotenoids in Fruits, Vegetables and Human Plasma by High Performance Liquid Chromatography. Pure & Appl. Chem. 63(1):71-80, 1991.

Knudsen, K. E. B. and Li, B. W. Determination of Oligorsaccharides in Protein Rich Feedstuffs by Gas-Liquid Chromatography and High Performance Liquid Chromatography. J. Agric. Food Chem. Vol. 39(4):689-694, 1991.

LaCroix, D. E., Zainal, H. A., and Wolf, W. R. The Reaction of Selenomethionine with Cyanogen Bromide. Presented at 105th Meeting of Association of Official Analytical Chemists, Phoenix, Arizona, August 1991. (Abstract)

Li, B. W. Updates on Dietary Fiber Analysis in Foods. Presented at Fifth Conference for Federally Supported Human Nutrition Research, Bethesda, Maryland, April 1991. (Abstract)

Li, B. W. Nonenzymatic-Gravimetric Determination of Total Dietary Fiber Content of Fruits and Vegetables. Presented at 105th Meeting of Association of Official Analytical Chemists, Phoenix, Arizona, August 1991. (Abstract)

Miller-Ihli, N. J. Particle Size Considerations for Slurry GFAAS. Presented at 37th Canadian Spectroscopy Conference, Ottawa, Canada, August 1991, Paper #16. (Abstract)

Miller-Ihli, N. J. Determination of Metals in Biological Samples by Slurry GFAAS. Presented at Kitami Conference on New Approaches in Trace Analysis by Atomic Spectrometry, Kitami, Japan, September 1991. (Abstract)

Miller-Ihli, N. J. Improved Solid Sampling Using Slurry Graphite Furnace Atomic Absorption Spectrometry. Presented at International Congress of Analytical Sciences, Tokyo, Japan, August 1991. (Abstract)

Miller-Ihli, N. J. A Novel Approach for the Direct Analysis of Solids. Presented at XXVII Colloquium Spectroscopicum Internationale, Bergen, Norway, June 1991. (Abstract)

Miller-Ihli, N. J. The Benefits of Ultrasonic Agitation for Slurry Graphite Furnace Atomic Absorption Spectrometry. Presented at XXVII Colloquium Spesctroscopicum Internationale, Lofthus, Norway, June 1991. (Abstract)

Miller-Ihli, N. J. A Novel Approach for Multielement Graphite Furnace Analysis of Solids. Presented at Pittsburgh Conference and Exhibition, Chicago, Illinois, March 1991. (Abstract)

Miller-Ihli, N. J. Multielement Slurry GFAAS of Biological Materials. Presented at Federation of Analytical Chemistry & Spectroscopy Societies, Anaheim, California, October 1991. (Abstract)

Riby, P. G., Harnly, J. M., Styris, D. L. and Ballou, N.E. Emission Characteristics of Chromium in Hollow Anode-furnace Atomization Non-thermal Excitation Spectrometry. Spectrochemica Acta. Vol. 46B, No. 2:203-215, 1991.

Riby, P. G., Harnly, J. M., and Styris, D. L. The Determination of Boron by Hollow-Anode Furnace Atomisation Non-Thermal Excitation Spectrometry. Presented at Pittsburgh Conference and Exhibition, Chicago, Illinois, March 1991. (Abstract)

Riby, P. G., Harnly, J. M., Styris, D. L., and Ballou, N. E. Advances in Hollow-Anode Fanes. Presented at the Federation of Analytical Chemistry and Spectroscopy Societies, Anaheim, California, October 1991. (Abstract)

Riby, P. G., Harnly, J. M., Styris, D. L., and Ballou, N. E. The Effect of Cathode Temperature and Thermionic Electrons on Emission Signals for Ha-Fanes. Presented at the Federation of Analytical Chemistry & Spectroscopy Societies, Anaheim, California, October 1991. (Abstract)

Russell, L. F. and Vanderslice, J. T. A Comprehensive Review of Vitamin B2 Analytical Methodology. J. Micronutr. Anal. 8:257-310, 1991.

Vanderslice, J. T. and Higgs, D. J. Vitamin C: Sample Variability: Forms in Food and Plasma. Am. J. of Clin. Nutr. 54:1323S-7S, 1991.

Vanderslice, J. T. and Higgs, D. J. Ascorbic Acid, Dehydroascorbic Acid and Total Vitamin C in Foods: Implications for Diet Studies. Presented at Fifth Conference for Federally Supported Human Nutrition Research, Bethesda, Maryland, April 1991. (Abstract)

Wolf, W. R. Editoral: Reference Materials. American Laboratory. Pg. 59, May 1991.

Wolf, W. R. and Tanner, J. T. Reference Materials for Nutrition Labeling. Presented at 105th Meeting of Association of Official Analytical Chemists, Phoenix, Arizona, August 1991. (Abstract)

Zainal, H. A., LaCroix, D. E., and Wolf, W. R. Comparative HPLC Analyses for the Reaction of CNBR with Selenomethionine and Methionine. Presented at CHROMOEXPO '91, Washington, D.C., May 1991. (Abstract)

Vitamin and Mineral Nutrition Laboratory
Beltsville Human Nutrition Research Center
Beltsville, Maryland 20705

Mission: The mission of the Vitamin and Mineral Nutrition Laboratory focuses on four main areas; (1) determine human requirements and basic mechanisms of action for specific vitamins and minerals; (2) identify chemical forms and bioavailabilities of vitamins and minerals in foods; (3) develop analytical instrumentation and techniques for assessment of minerals and vitamins in human nutrition; (4) develop and integrate cost-effective cellular, molecular and immunological methods for evaluating micronutrient bioavailability, interactions and requirements.

Dr. James C. Smith, Jr.
Research Leader
Supervisory Research Chemist
Room 117, Building 307
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301/504-8351

Provides leadership to the laboratory. Investigates metabolism of zinc, copper, carotenoids, and vitamin A in animal models and humans. Assess methods for determining nutritional status for trace elements and vitamin A and studies specific nutrient interactions, such as vitamin A and zinc.

Dr. Richard Anderson
Research Chemist
Room 224, Building 307
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Investigates the effects of dietary chromium on risk factors associated with maturity-onset diabetes and cardiovascular diseases. Determines the effects of various stresses, primarily diet and exercise, on trace metal metabolism. Develops methods to assess chromium status and determine its mechanism of action.

Dr. Tim R. Kramer
Research Biologist
Room 216, Building 307
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Investigates the role of nutrients on the immune system. Determine nutrient requirements of humans experiencing various stress conditions, for optimal immune function in the host defense system, resulting in improved health status.

Dr. Orville A. Levander
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Investigates the role of selenium and vitamin E in human nutrition as can be clarified through studies on the functions and biochemical mode of action of selenium and vitamin E and their inter-relationships. Other studies on the physiological need for these nutrients aim at determining the requirements under different conditions of stress (for example, parasitic infection) and development of accurate methods for assessing their status in humans.

Dr. Eugene Morris
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Investigates the impact of bioavailability factors on human mineral nutriture. A specific problem addressed is the amount of phytic acid and other inositol phosphates in foods as eaten.

Dr. Claude Veillon
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Studies metabolism of trace elements required for human nutrition and develops new, accurate and precise methodologies for determination of trace elements in biological materials. Special attention is given to development of methods for measuring trace element status and requirements in humans using stable isotopes.

RECENT RESEARCH ACCOMPLISHMENTS

Use of Caco-2 Cell Line to Assess Nutrient Bioavailability and Interactions

Although fructose consumption has increased markedly in the U.S., the mechanisms of absorption of this sugar have not been as well studied as glucose. To study this we used Caco-2 cells as a model, since cultures of this human cell line develop many of the morphological and biochemical characteristics of mature enterocytes. Carbon-14-fructose was converted to CO2, glycogen and lipid, although at a level of 25-75% lower than for C-14 glucose. Addition of glucose, galactose, mannose or 2-deoxyglucose to the medium with C-14-fructose decreased incorporation of the radiolabel into CO2 and lipid. Fructose uptake by postconfluent cultures was 20-50% that of glucose. In addition, fructose uptake was decreased by addition of either glucose, galactose, or 2-deoxyglucose to the medium. Thus, fructose can serve as a carbon and energy source for the cells, but other simple sugars may impair its uptake and metabolism.

Relationship of Copper, Selenium and Vitamin E to Cardiomyopathy in The Young, Growing Pig

Copper, selenium and vitamin E are involved in protecting the body from oxidative damage. Fructose has been suggested to initiate oxidative damage and to exacerbate copper deficiency. Therefore, this eight week study's goals were to examine the interrelationship between carbohydrates and copper, selenium and vitamin E. Casein based diets contained either 50% fructose, glucose or starch and either 6 ppm or 0.6 ppm copper. Mortality was greater in the fructose and glucose groups than starch. Hepatic glutathione peroxidase was not affected by diet but superoxide dismutase was decreased by the marginal copper diet. Circulating and cardiac vitamin E were higher in pigs fed starch. Regardless of treatment, histologic lesions suggestive of oxidant damage were found in 23 of 40 animals. These data suggest that copper may not be the only nutrient related to abnormalities associated with this interrelationship.

Lack of Effect of Dietary Copper on Vitamin A Status

Several vitamin-mineral interactions have been documented including zinc and vitamin A. Copper and zinc share several similarities as transitional elements and have been shown to interact competitively. Indeed, a recent publication suggested "that a copper-deficient diet may cause defective transport of vitamin A ...", as has been forwarded in the case of zinc deficiency. Therefore, we designed a study using an experimental model (rats) fed copper deficient or adequate diets and controlled for food intake and weight gain. The copper deficiency was verified by several parameters. However, in spite of the marked copper deficiency, parameters of vitamin A status (serum and liver vitamin A concentrations) were not statistically different from the animals fed adequate dietary copper. Therefore, using this experimental model, we conclude that unlike zinc deficiency, inadequate dietary copper does not affect vitamin A metabolism. These data suggest that the vitamin A-zinc interaction is specific.

Effect of Supplementation of Vitamin A and Zinc to Children of Marginal Status for These Nutrients

One-hundred thirty three children in Thailand, 6 to 13 years with marginal plasma vitamin A and zinc concentrations, participated in a double blind study. They were supplemented with either zinc (25 mg/day), vitamin A (1500 retinol equivalents/day), a combination of zinc and vitamin A or placebo for six months. Biochemical indices of

vitamin A and zinc status increased significantly. Zinc supplementation resulted in improvement of vision restoration time in dim light (dark adaptometry). Vitamin A and zinc synergistically normalized conjunctival epithelium as measured by conjunctival impression cytology. Both functional indices (dark adaptation and conjunctival impression cytology) showed significant correlation with plasma zinc and vitamin A, respectively. The data suggest that functional improvements of populations with suboptimal vitamin A and zinc nutriture can be accomplished by supplementation with less than two times the Recommended Dietary Allowance of these nutrients.

Chromium Intake of Breast-fed Infants

Breast milk chromium content of 17 lactating women 60 days postpartum was analyzed to determine actual chromium intake of breast-fed infants. Dietary chromium intake of exclusively breast-fed infants was less than 2% of the minimum suggested safe and adequate daily intake. Present recommendations appear to be too high and need to be redefined.

Insulin Stimulation is Altered by Albumin

Albumin is routinely added to the media when measuring insulin activity. However, our data demonstrate that while albumin activates insulin activity due to certain extracts such as those of brewer's yeast it inhibits activity of others, i.e., cinnamon. These data demonstrate that albumin effects need to be evaluated when assessing insulin activity.

Exercise, Chromium and Trace Element Content of Tissues

Supplemental chromium caused an increase in copper, zinc and manganese concentrations in liver and pancreas of rats independent of training. Aerobic training led to increases in chromium, copper, iron, manganese and zinc in epididymal fat tissue. Copper concentrations of pancreas, kidney zinc and copper and zinc concentrations in gastrocnemius muscle were also higher. These data demonstrate that supplemental chromium and training lead to alter trace metal concentrations in tissues.

Dietary Chromium Intake and Breast Milk Chromium Content

Dietary intake of chromium was shown to be independent of breast milk chromium content. Chromium concentrations in urine and serum also did not correlate with breast milk chromium concentration. However, there was a highly significant correlation of serum and urinary chromium. These data demonstrate that breast milk chromium is not closely regulated by dietary intake and that urinary chromium concentration is an accurate reflection of chromium circulating in blood.

Chromium Improves Blood Glucose and Insulin Values

Chromium improved glucose tolerance and insulin values of chromium supplemented rats. Insulin responses were 43% lower and glucose 18% lower in chromium supplemented animals. These data demonstrate that dietary chromium improved glucose tolerance and decreases circulating insulin thereby enhancing tissue insulin sensitivity.

Effects of Multiple Stressors During U.S. Army Ranger Training on Cell-Immune Functions

We sought to determine the effects of stressors, nutritional/physical, psychological, encountered during the 62-day Army Ranger Training Course on inflammatory and cellular immune functions. T-lymphocyte function in vitro blastogenesis and interleukin-2 production, is suppressed in trainees during the Ranger Training Course. The inflammatory/immunomodulating cytokine interleukin-6 is likewise reduced in the trainees during the Ranger Training Course. Our results demonstrate that the multiple stressors including food restriction, encountered during the Ranger Training Course suppress cellular immune functions in otherwise healthy, normal men.

Effects of Micronutrient Supplementation on T-Lymphocyte Blastogenesis of Adults in Linxian County, China

We sought to determine the effects of micronutrient supplementation of adults with minerals and vitamins on cellular immune functions. Four hundred adults supplemented with selected micronutrients for five years were studied. Males supplemented with riboflavin, niacin, vitamin C and molybdenum showed significantly lower T-lymphocyte blastogenesis in vitro than males supplemented with selenium, vitamin E, beta-carotene, vitamin A and zinc. Males, but not females, supplemented with micronutrient combinations containing vitamin C and molybdenum showed lower T-lymphocyte blastogenesis than those not receiving them. Our results show that supplementation of males with combined vitamin C and molybdenum appear to have a suppressive effect on blastogenesis of T-lymphocytes.

Aging, Diet, and Selenium Toxicity Alter Proton NMR Spectra of Rat Urine

Proton Nuclear Magnetic Resonance (PNMR) is a rapid method for the multi-component analysis of biofluids that requires no separation techniques. The non-selective nature of this procedure allows the detection and identification of a large number of low-molecular weight metabolites in urine with little or no sample pretreatment. We have found specific shifts in certain urinary metabolites as a result of aging, the type of diet fed, and selenium poisoning. Determination of urinary metabolite profiles by PNMR may allow development of selective tests for assessing a variety of physiologic states.

No Evidence of Selenium Toxicity Found in a Human Population Residing in a Naturally Seleniferous Area

Adult men and women were recruited from South Dakota and Wyoming ranches where unusually high selenium intakes were suspected in order to determine whether high dietary selenium intake was associated with any adverse effects. Volunteers completed health questionnaires, underwent physical examinations, and provided blood samples for clinical assessment. Although dietary intakes more than 700 ug/day were reported, no physical findings characteristic of selenium toxicity were observed and no clinically significant changes in laboratory tests could be related to selenium exposure.

Kinetic Modeling with Stable Isotopes Reveals Significant Differences in the Pharmacokineties of Organically-bound vs. Inorganic Selenium in Humans

Adult volunteers received a single oral dose of a stable isotope of 74-selenium in the form of selenomethionine. A kinetic model was developed to account simultaneously for the appearance and disappearance of the tracer in plasma, urine, and feces. The

whole body turnover of selenomethionine was considerably slower than that of selenite and this was ascribed to a substantial reutilization of selenium in this form. Such reutilization would have advantages for repleting persons of poor selenium status but might pose hazards to individuals exposed to excessive quantities of the element.

Ground Flaxseed and Ethyl Linolenate Protect Vitamin E Deficient Mice Against Malaria

Several oils containing highly unsaturated fatty acids have marked antimalarial activity when fed to vitamin E deficient mice. Acceptance of such oils, however, could pose problems for field intervention trials. Incorporation of ground flaxseed into various baked goods could provide a convenient vehicle for the introduction of omega-3 fatty acids into Third World population groups as a means of malaria control. The fact that chemically pure linolenic acid exerted a significant antimalarial effect in tocopherol-deficient mice indicates that the antimalarial effect of fish oils and linseed oil can be accounted for solely on the basis of their omega-3 fatty acid content.

Ascorbic Acid and Urinary Iron Excretion

Ascorbic acid enhances absorption of nonheme iron in single meal studies. However, only iron depleted individuals show an increase in iron stores, when measured by serum ferritin levels with continued consumption of ascorbic acid in meals. We investigated the question "could ascorbic acid increase urinary iron excretion and consequently negate the anticipated increase in body iron stores from enhanced nonheme iron absorption? Twelve ostensibly healthy adult men consumed approximately ten times the RDA of ascorbic acid with each of the two main meals daily for eight weeks. During the second week of ascorbic acid supplementation, mean daily urinary iron excretion was about 25% greater than for the week before supplementation, then tended to decrease from that maximum. Although urinary iron excretion tended to remain higher than pre-supplementation, the overall level of excretion for eight weeks was not statistically significant. We concluded that body iron homeostasis in the presence of high ascorbic acid consumption is not mediated through urinary iron excretion.

Effect of Stress on the Biochemical Indices of Trace Minerals in Men

The objective of the study was to determine whether sustained physical and psychological stress would alter biochemical indices of trace mineral status in young, healthy men after they had undergone five weeks of prolonged physical training at submaximal intensities. Specifically, we were interested in determining the effects of five consecutive days of sustained physiological stress on biochemical indices of zinc, iron, copper, and selenium status in healthy, physically trained men. Subjects were 119 trainees from the US Navy Sea, Air, and Land (SEAL) training classes at the Basic Underwater Demolition School/SEAL Training Center in Coronado, California. Each was studied before and immediately after a period known as "Hell Week", a five-day period during which the trainees are subjected to extreme physical and psychological stress. The stress produced changes characteristic of an acute-phase response. Plasma zinc, iron, and selenium declines, while ferritin, ceruloplasmin, C-reactive protein, creatine kinase, and white blood cell counts rose. These changes were transient because all of the variables studied, except ferritin, returned to baseline values within one week after the sustained stress.

PUBLICATIONS

1989

Anderson, R.A. Essentiality of chromium in humans. Sci. Total Environment 86:75-81, 1989.

Anderson, R.A. Present knowledge of chromium and its role in physical performance. Vitamine Mineralstoffe Spurenelemente in Medizin, Enahrung und Umwelt 4:14-18, 1989.

Anderson, R.A., Bryden, N.A., Polansky, M.M., Richards, M.P. Chromium supplementation of turkeys: effects on tissue chromium. J. Agric. Food. Chem. 37:131-134, 1989.

Babu, U., Failla, M.L. Superoxide dismutase activity and blastogenic response of lymphocytes from copper-deficient rats fed diets containing fructose or cornstarch. Nutr. Res. 9:273-282, 1989.

Brown, E.D., Micozzi, M.S., Craft, N.E., Bieri, J.G., Beecher, G., Edwards, B.K., Rose, A., Taylor, P.R., Smith, J.C., Jr. Plasma carotenoids in normal men after a single ingestion of vegetables or purified beta-Carotene. Am. J. Clin. Nutr. 49:1258-1265, 1989.

Brown, E.D., Rose, A., Craft, N., Seidel, K.E., Smith, J.C., Jr. Plasma concentrations of carotenoids, retinol and tocopherol in response to ingestion of a meal. Clin. Chem. 35:310-312, 1989.

Campbell, W.W., Polansky, M.M., Bryden, N.A., Soares, J.H. Jr., Anderson, R.A. Exercise training and dietary chromium effects on glycogen, glycogen synthase, phosphorylase and protein in rats. J. Nutr. 119:653-660, 1989.

Chen, M.L., Failla, M.L. Degradation of zinc-metallothionein in monolayer cultures of rat hepatocytes. Proc. Soc. Exp. Biol. Med. 191:130-138, 1989.

Erardi, F.X., Failla, M.L. and Falkinham, J.O. III. Accumulation and transport of cadmium by tolerant and susceptible strains of *Mycobacterium scrofulaceum*. Antimicrob. Agents Chemother. 33:350-355, 1989.

Forbes, A.L., Adams, C.E., Arnaud, M.J., Chichester, C.O., Cook, J.D., Harrison, B.N., Hurrell, R.F., Khan, S.G., Morris, E.R., Tanner, J.T. and Whittaker, P. Report of the international nutritional anemia consultative task force on iron bioavailability. Am. J. Clin. Nutr. 49:225-238, 1989.

Hill, A.D., Morris, E.R., Ellis, R., Moy, T.F. and Moser-Veillon, P.B. Are analyses of duplicate plate collections true measures of nutrient intake. Fed. J. 3:A658, 1989 (Abstract).

Holbrook, J.T., Smith, J.C., Jr. and Reiser, S. Effects of dietary fructose or starch on copper, zinc, iron, manganese, calcium and magnesium balances in humans. Am. J. Clin. Nutr. 49:1290-1294, 1989.

Kant, A.A., Moser-Veillon, P.B. and Reynolds, R.D. Dietary Intakes and Plasma Concentrations of Zinc, Copper, Iron, Magnesium and Selenium of Young, Middle-Aged and Older Men. Nutr. Res. 9:717-724, 1989.

Levander, O.A., Ager, A.L., Morris, V.C. and May, R.G. Effect of Qinghaosu and dietary vitamin E, selenium and cod liver oil on the susceptibility of mice to the malarial parasite *Plasmodium yoelii*. Am. J. Clin. Nutr. 50:346-352, 1989.

Morris, E.R. and Ellis, R. Usefulness of the dietary phytic acid/zinc molar ratio as an index of zinc bioavailability to rats and humans. Biol. Trace Elem. Res. 19:107-117, 1989.

Sherman, S.S., Smith, J.C. Tobin, J.D. and Soares, J.H. The effect of ovariectomy and dietary zinc on bone metabolism in retired breeder rats. Am. J. Clin. Nutr. 49:1184-91, 1989.

Veillon, C. Analytical chemistry of chromium. Sci. Total Environment 86:65-68, 1989.

1990

Albanes, D., Salbe, A.D., Levander, O.A., Taylor, P.R., Nixon, D.W. and Winick, M. The effect of early caloric restriction on colonic cellular growth in rats. Nutr. Cancer 13:73-80, 1990.

Anderson, R.A. Effects of exercise, physical trauma, and high sugar intake on chromium, copper and zinc metabolism. In: Trace Elements in Clinical Medicine, ed. H. Tomita, Springer-Verlag, Tokyo, pp. 185-192, 1990. (Book Chapter)

Anderson, R.A. Nutritional role of chromium in glucose and lipid metabolism of humans. Metal Ions, eds. P. Collery, L.A. Poirier, M. Manfait and J.-C. Etienne, John Libbey, London, pp. 95-99, 1990.

Anderson, R.A., Bryden, N.A., Polansky, M.M. and Reiser, S. Urinary chromium excretion and insulinogenic properties of carbohydrates. Am. J. Clin. Nutr. 51:864-868, 1990.

Babu, U. and Failla, M.L. Respiratory burst and cardidacidal activity of peritoneal macrophages are impaired in copper deficient rats. J. Nutr. 120:692-699, 1990.

Babu, U. and Failla, M.L. Copper status and function of neutrophils are reversibly depressed in marginally and severely copper deficient rats. J. Nutr. 120:1700-1709, 1990.

Bacon, M.C., White, P.H., Raiten, D.J., Margolis, S., Levander, O.A., Taylor, M.L., Lipnick, R.N. and Sami, S. Nutritional status and growth in juvenile rheumatoid arthritis. Seminars Arthritis Rheumatism 20:97-106, 1990.

Bala, S., Failla, M.L. and Lunney, J. Phenotypic and functional alterations in peripheral blood mononuclear cells of copper deficient rats. Ann. N.Y. Acad. Sci. 587:283-285, 1990.

Bala, S., Failla, M.L. and Lunney, J. T cell numbers and mitogenic responsiveness of peripheral blood mononuclear cells are decreased in copper efficient rats. Nutr. Res. 10:749-760, 1990.

Briske-Anderson, M. and Kramer, T.R. Influence of zinc on Bacillus Calmette-Guerin cell wall skeleton induced suppression of concanavalin-A stimulated DNA-synthesis of rat splenic T-lymphocytes. Nutr. Res. 10:635-646, 1990.

Burns, W.A., Fields, M., Smith, Jr., J.C. and Reiser, S. Myocardial Lesions in Copper Deficiency Modified by Dietary Carbohydrates. J. Trace Elem. in Exp. Med. 3:67-77, 1990.

Campbell, W.W., Polansky, M.M., Bryden, N.A., Soares, J.H., Jr., and Anderson, R.A. Dietary chromium and exercise training effects on glucose cholesterol and related variables. J. Trace Elem. Expt. Med. 3:295-305, 1990.

Engelhardt, S., Moser-Veillon, P.B., Mangels, A.R., Patterson, K.Y. and Veillon, C. Appearance of an oral dose of chromium (^{53}Cr) in breast milk? In: Breastfeeding, Nutrition, Infection and Infant Growth in Developed and Emerging Countries. S.A. Atkinson, L.A. Hanson and R.K. Chandra, eds. ARTS Biomedical Publishers, St. John's, Newfoundland (Canada), pp. 485-487, 1990.

Khan, A., Bryden, N.A., Polansky, M.M. and Anderson, R.A. Insulin potentiating factor and chromium content of selected foods and spices. J. Biol. Trace Elem. 24:183-188, 1990.

Kramer, T.R., Praputpittaya, K., Yuttabootr, Y., Singkamani, R. and Trakultivakorn, M. Relationship between plasma zinc and cellular immunity to Candida albicans in young females of northern Thailand. Ann. New York Acad. Sci. 587:300-302, 1990.

Kramer, T.R., Johnson, W.T. and Briske-Anderson, M. Erythrocytes and latex particles correct the impaired mitogenic reactivity of spleen lymphoid cells from copper deficient rats. Ann. New York Acad. Sci. 587:297-299, 1990.

Kramer, T.R., Johnson, W.T. and Briske-Anderson, M. Erythrocytes and latex particles enhance blastogenesis of concanavalin-A stimulated spleen lymphoid cells from copper deficient rats. Nutr. Res. 10:303-314, 1990.

Levander, O.A. Selenium: essentiality vs. toxicity in man. J. Environ. Geochem. Health 12(Suppl.):11-19, 1990.

Levander, O.A., Ager, A.L., Morris, V.C. and May, R.G. Plasmodium yoelii: comparative antimalarial activities of dietary fish oils and fish oil concentrates in vitamin E-deficient mice. Exp. Parasitol. 70:323-329, 1990.

Levander, O.A., Ager, A.L., Morris, V.C. and May, R.G. Protective effect of linseed oil against malaria in vitamin E-deficient mice. Flax Institute of the U.S., Proc. 53:16-18, 1990.

Levander, O.A. and Burk, R.F. Selenium. In: Present Knowledge in Nutrition, M. Brown (ed.), ILSE/Nutrition Foundation, Washington, DC, pp. 268-273, 1990. (Review)

Mangels, A.R., Moser-Veillon, P.B., Andon, M.B. and Reynolds, R.D. Vitamin B-6 intake of lactating women: analyzed vs calculated values. J. Am. Dietet. Assoc. 90(6):857-859, 1990.

Mangels, A.R., Moser-Veillon, P.B., Engelhardt, M.S., Patterson, K.Y. and Veillon, C. Appearance in breast milk of two forms of selenium given simultaneously as stable isotope tracers to lactating women. In: Breastfeeding, Nutrition, Infection and Infant Growth in Developed and Emerging Countries. S.A. Atkinson, L.A. Hanson and R.K. Chandra, eds., ARTS Biomedical Publishers, St. John's, Newfoundland (Canada), pp. 489-490, 1990.

Mangels, A.R., Moser-Veillon, P.B., Patterson, K.Y. and Veillon, C. Selenium utilization during human lactation by use of stable isotope tracers. Am. J. Clin. Nutr. 52:621-627, 1990.

Morris, E.R. Book review: "Nutrient Availability: Chemical and Biological Aspects", Eds. D.A.T. Southgate et al., Royal Society of Chemistry, Thomas Graham House, Cambridge, U.K. J. Food Comp. Anal. 3:1-2, 1990.

Moser-Veillon, P.B. and Reynolds, R.D. A longitudinal study of pyridoxine and zinc supplementation of lactating women. Am. J. Clin. Nutr. 52:135-41, 1990.

Oberleas, D., Li, Y.-C., Stoecker, B.J., Henley, S.A., Keim, K.S. and Smith, J.C., Jr. The rate of chromium transit through the gastrointestinal tract. Nutr. Res. 10:1189-1194, 1990.

Oberleas, D. and Smith, J.C. The importance of endogenous zinc in homeostasis. 6th Intl. Trace Elem. Symp. 1989. (M. Anke, W. Baumann, H. Braunlich, Chr Bruckner, B. Groppel and M. Grun (eds.) Karl-Marx-Universitaat, Leipzig and Friedrich-Schiller-Universitat, Jena, West Germany, Vol. 2, pp. 676-679, 1990.

Reynolds, R.D. Determination of dietary vitamin B-6: is it accurate? J. Am. Dietet. Assoc. 90:799-801, 1990.

Reynolds, R.D., Andon, M.B. and Moser-Veillon, P.B. Letter to the Editor. Am. J. Clin. Nutr. 51:1116-7, 1990.

Salbe, A.D., Albanes, D., Winick, M., Taylor, P.R., Nixon, D.W. and Levander, O.A. The effect of elevated selenium intake on colonic cellular growth in rats. Nutr. Cancer 13:81-87, 1990.

Salbe, A.D. and Levander, O.A. Comparative toxicity and tissue retention of selenium in methionine-deficient rats fed sodium selenate or L-selenomethione. J. Nutr. 120:207-212, 1990.

Salbe, A.D. and Levander, O.A. Effect of various dietary factors on the deposition of selenium in the hair and nails of rats. J. Nutr. 120:200-206, 1990.

Schoenemann, H.M. III, Failla, M.L. and Fields, M. Consequences of copper deficiency are not differentially influenced by carbohydrate source in young pigs fed a dried skim milk-based diet. Biol. Trace Element Res. 25:21-33, 1990.

Schoenemann, H.M. III., Failla, M.L. and Steele, N.C. Consequences of copper deficiency are independent of dietary carbohydrate in young pigs. Am. J. Clin. Nutr. 50(1):147-154, 1990.

Scholfield, D.J., Reiser, S., Fields, M., Steele, N.C., Smith, J.C., Jr., Darcey, S. and Ono, K. Dietary copper, simple sugars, and metabolic changes in pigs. J. Nutr. Biochem. 1:362-367, 1990.

Swanson, C.A., Longnecker, M.P., Veillon, C., Howe, S.M., Levander, O.A., Taylor, P.R., McAdam, P.A., Brown, C.C., Stampfer, M.J. and Willett, W.C. Relation of selenium intake, age, gender and smoking to indices of selenium status of adults residing in seleniferous area. Am. J. Clin. Nutr. 52:858-862, 1990.

Udomkesmalee, E., Dhanamitta, S., Yhoung-Aree, J., Rojroongqasinkul, N. and Smith, J.C. Biochemical evidence suggestive of suboptimal zinc and vitamin A status in schoolchildren in Northeast Thailand. Am. J. Clin. Nutr. 52:564-567, 1990.

Veillon, C., Patterson, K.Y., Button, L.N. and Sytkowski, A.J. Selenium utilization in humans - a long-term self-labeling experiment with stable isotopes. Am. J. Clin. Nutr. 52:155-158, 1990.

1991

Anderson, R.A., Bryden, N.A., Polansky, M.M. and Thorp, J.W. Effects of carbohydrate loading and underwater exercise on circulating cortisol, insulin and urinary losses of chromium and zinc. Eur. J. Physiol. 63:146-150, 1991.

Anderson, R.A., Polansky, M.M., Bryden, N.A. and Canary, J.J. Supplemental chromium effects on glucose, insulin, glucagon and urinary chromium losses of subjects consuming controlled low chromium diets. Am. J. Clin. Nutr. 54:909-916, 1991.

Apgar, J., Dulin, A., Kramer, T. and Smith, J.C. Reduced survival of neonates due to vitamin A deficiency during pregnancy in the guinea pig. Proc. Soc. Exp. Biol. Med. 197:56-58, 1991.

Bala, S., Failla, M.L. and Lunney, J. Alterations in the splenic lymphoid cell subsets and activation antigens in copper deficient rats. J. Nutr. 121:745-753, 1991.

Bell, J.D., Sadler, P.J., Morris, V.C. and Levander, O.A. Effects of aging and diet on proton NMR spectra of rat urine. Magnetic Resonance in Medicine 17:414-422, 1991.

Kramer, T.R., N. Schoene, L.W. Douglass, J.T. Judd, R. Ballard-Barbash, P.R. Taylor, H.N. Bhagavan and P.P. Nair. Increased vitamin E intake restores fish oil induced suppressed blastogenesis of mitogen stimulated T-lymphocytes. Am. J. Clin. Nutr. 54:896-902, 1991.

Levander, O.A. Scientific rationale for the 1989 Recommended Dietary Allowance for selenium. J. Am. Diet. Assoc. 91:1572-1576, 1991.

Levander, O.A., Ager, A.L., Morris, V.C. and May, R.G. Protective effect of ground flaxseed or ethyl linolenate in a vitamin E-deficient diet against murine malaria. Nutr. Res. 11:941-948, 1991.

Longnecker, M.P., Taylor, P.R., Levander, O.A., Howe, S.M., Veillon, C., McAdam, P.A., Patterson, K.Y., Holden, J.M., Stampfer, M.J., Morris, J.S., Willett, W.C. Selenium tissue levels and dietary intake in relation to human health in a seleniferous area. Am. J. Clin. Nutr. 53:1288-1294, 1991.

Mertz, W., Tsui, J.C., Judd, J.J., Reiser, S., Hallfrisch, J., Morris, E.R., Steele, P.S. and Lashley, E. What are people really eating? The relation between energy intake derived from estimated diet records and intake determined to maintain body weight. Am. J. Clin. Nutr. 54:291-295, 1991.

Raiten, D.J., Reynolds, R.D., Andon, M.B., Robbins, S.T. and Fletcher, A.B. Vitamin B-6 metabolism in premature infants. Am. J. Clin. Nutr. 53:78-83, 1991.

Reynolds, R.D. Maternal vs. fetal origin of fetal plasma pyridoxal 5'-phosphate. Nutrition 7:264-66, 1991.

Reynolds, R.D., Lorenc, R.S., Wieczorek, E and Pronicka, E. Extremely low serum pyridoxal 5'-phosphate in children with familial hypophosphatemic rickets. Am. J. Clin. Nutr. 53:698-701, 1991.

Seidel, K.E., Failla, M.L. and Rosebrough, R.W. Cardiac catecholamine metabolism in copper-deficient rats. J. Nutr. 121:474-483, 1991.

Singh, A., Smoak, B.L., Patterson, K.Y., Lemay, L.G., Veillon, C. and Deuster, P.A. 1991. Biochemical indices of selected trace minerals in men: effect of stress. Am. J. Clin. Nutr. 53:126-131.

Smith, M.A., Moser-Veillon, P.B., Nagey, D.A., Douglas, L.W. and Smith, J.C. Effect of a glucose challenge on plasma copper levels during pregnancy. J. Am. College of Nutr. 10:11-16, 1991.

Swanson, C.A., Patterson, B.H., Levander, O.A., Veillon, C., Taylor, P.R., Helzlsouer, K., McAdam, P.A. and Zech, L.A. Human [^{74}Se] selenomethionine metabolism: a kinetic model. Am. J. Clin. Nutr. 54:917-926, 1991.

1991 ABSTRACTS

Ager, A.L., Levander, O.A., et al. Chloroquine-resistant (CR) but not sensitive (CS) Plasmodium vinckei cured in mice by menhaden oil (MO) diet deficient in vitamin E (-VE). FASEB J. 5:A1081, 1991.

Anderson, R.A. Regulation of glucose tolerance by dietary chromium. Fifth Conference for Federally Supported Human Nutrition Research, Bethesda, MD 1991.

Anderson, R.A. New insights on the trace elements, chromium, copper and zinc, and exercise. In: Medicine and Sport Science, S. Karger, AG Basel, Switzerland. Vol. 32, pp. 38-58, 1991.

Anderson, R.A., Bryden, N.A. and Polansky, M.M. Dietary intake of chromium, copper, zinc, iron, manganese, calcium and magnesium: Duplicate plate technique - measured and derived. FASEB J. 5:A5454, 1991.

Anderson, R.A., Polansky, M.M., Bryden, N.A., Canary, J.J. and Mertz, W. Chromium requirement is related to degree of glucose intolerance. Proceedings Trace Elements in Man and Animals, Vol. 7. Institute Med. Res. and Occup. Health Univ., Zagreb, Yugoslavia, pp. 3-4-3-6, 1991.

Bala, S., Deshpande, S. and Failla, M.L. Exogenois IL-2 and copper restore in vitro mitogenic reactivity of splenic mononuclear cells from copper deficient rats. FASEB J. 5:1074, 1991.

Block, G., Mangels, A.R., Levander, O.A. et al. Plasma reduced and oxidized ascorbic acid attained on various levels of dietary intake. FASEB J. 5:A1444, 1991.

Cheng, N., Anderson, R.A., Bryden, N.A., Polansky, M.M. and Mertz, W. Chromium interaction with liver nucleic acids. Proceedings Trace Elements in Man and Animals, Vol. 7. Institute Med. Res. and Occup. Health Univ., Zagreb, Yugoslavia, pp. 3-8, 1991.

Deurenberg, P., Reynolds, R.D., Howard, M.P., Pietersma, A. and Destoppelaar, J. Changes in body composition during exposure to extreme altitude. FASEB J. 5:1128, 1991.

Dulin, A.M., Smith, Jr., J.C. and Bieri, J.G. Effect of Zinc or Copper Status on the Conversion of Beta-Carotene to Vitamin A. FASEB J. 5:A1321, 1991.

Hill, A.D. and Morris, E.R. Ascorbic acid supplementation and urinary iron excretion by adult men. FASEB J. 5:A590, 1991.

Hill, G.M., Link, J.E., Kerr, C.A., Turk, J.R., Sunde, R.A., Stowe, H.D. and Smith, Jr., J.C. Relationship of Cu, Se and Vitamin E to a Cardiomyopathy in the Young, Growing Pig. University of Missouri Nutrition Symposium, September 1991.

Kramer, T.R., E. Udomkesmalee, S. Dhanamitta, S. Sirisinha, S. Charoenkiatkul, S. Tantipopipat, O. Banjong, N. Rojroongwasinkul and J.C. Smith, Jr. Enhanced T-lymphocyte blastogenic response to tuberculin (PPD) in children of Northeast (NE) Thailand supplemented with vitamin A (VA) and zinc (Zn). FASEB J. 5:A1292, 1991.

Kramer, T.R., E. Udomkesmalee, S. Dhanamitta, S. Sirisinha, S. Charoenkiatkul, S. Tantipopipat, O. Banjong, N. Rojroongwasinkul and J.C. Smith, Jr. Enhanced T-lymphocyte blastogenic response to tuberculin (PPD) in children of Northeast (NE) Thailand supplemented with vitamin A (VA) and zinc (Zn). XIV Int. Vit A Consult. Gr (IVACG), Guayaquil, Ecuador, p. 106, June 1991.

Lefavi, R.G., Anderson, R.A., Keith, R.E. and Wilson, G.D. Lipid lowering effect of a dietary nicotinic acid - chromium(III) complex in male athletes. FASEB J. 5:A7404, 1991.

Levander, O.A. Approaches to malarial control through dietary manipulation of host antioxidant status. IBC Conference Free Radicals as Targets for New Drugs, Philadelphia, PA, June 27-28, 1991.

Levander, O.A. Selenium and sulfur in antioxidant protective systems. Proc. U.S.-Japan Malnutrition Panel Symposium., p. 39, July 22-24, 1991.

Levander, O.A., Ager, A.L., Morris, V.C. and May, R.G. Comparative antimalarial effects of n-3 fatty acid ethyl esters in vitamin E-deficient (-VE) mice. FASEB J. 5:A1080, 1991.

Levander, O.A., Ager, A.L., Morris, V.C. and May, R.G. Suppression of malaria by dietary oxidative stress. 5th International Congress on Oxygen Radicals, Kyoto, Japan, November 17-21, p. 50, 1991.

Longnecker, M.P., Taylor, P.R., Levander, O.A., Flack, V., Veillon, C., McAdam, P.A., Patterson, K.Y., Holden, J., Stampfer, M.J., Morris, J.S, and Willett, W.C. Estimation of selenium (Se) intake from Se in serum, whole blood, toenails, or urine. FASEB J. 5:A716, 1991.

Makdani, D., Rizner, J. Hegar, A., Gunter, E., Sowell, A., and Smith, J.C. Vitamin A and Zinc Nutriture of Children in Belize, Central America FASEB J. 5:A953, 1991.

Mangels, A.R., Block, G., Levander, O.A., Taylor, P.R., Morris, V.C. and Patterson, B.H. Differences in plasma beta-carotene (P-BC) maintained despite similar dietary beta-carotene. FASEB J. 5:1322, 1991.

Mangels, A.R., Block, G., Levander, O.A., Taylor, P.R., Morris, V.C. and Patterson, B.H. Plasma carotenoids during ascorbic acid (AA) depletion and repletion. Proc. U.S.-Japan Malnutrition Panel Symposium., p. 50, July 22-24, 1991.

McCormick, R.J., Vadlamudi, R.K., Medieros, D.M. and Failla, M.L. Pyridinium crosslinking and collagen types in myocardium and valve are altered in copper deficient swine. FASEB J. 5:A1454, 1991.

Mertz, W., Tsui, J.C., Judd, J.J., Reiser, S., Hallfrisch, J., Morris, E.R., Steele, P. S. and Lashley, E. The relation between diet records and intakes to maintain body weight. FASEB J. 5:A1645, 1991.

Morris, E.R., Schwartz, R., Topley, M. and Anderson-Shaw, H. Comparison of in vitro solubility of minerals in meals and mineral balance of men consuming the same meals. FASEB J. 5:A1313, 1991.

Morris, V.C., Ager, A.L., Levander, O.A. and May, R.G. Effect of dietary fat and vitamin E (VE) status on response of mice to antimalarials. FASEB J. 5:A578, 1991.

Moser-Veillon, P.B., Mangels, A.R., Patterson, K.Y. and Veillon, C. Utilization of two different chemical forms of selenium during lactation using stable isotope tracers - An example of speciation in nutrition. XXVII-CSI Post-Symposium: Speciation of Elements in Environmental and Biological Sciences, Loen, Norway, June 16-18, 1991.

Moser-Veillon, P.B., Patterson, K.Y., Mangels, A.R., Wallace, G.F. and Veillon, C. Appearance of infused zinc (70Zn) and oral zinc (68Zn) in breast milk. FASEB J. 5:A921, 1991.

Oberleas, D., Finley, J. and Smith, J.C. Interaction Between Calcium and Phytate and its Affects on the Endogenous Zinc Pool. FASEB J. 5:A1646, 1991.

Patterson, K.Y., Moser-Veillon, P.B., Wallace, G.F. and Veillon, C. The determination of zinc stable isotopes in biological materials by isotope dilution ICP-MS after matrix separation. Federation of Analytical Chemistry and Spectroscopy Societies. Anaheim, CA. October 6-11, 1991.

Polansky, M.M., Bryden, N.A. and Anderson, R.A. Chromium (Cr) requirement is increased in subjects with impaired glucose tolerance. FASEB J. 5:A7405, 1991.

Reynolds, R.D., Kiehl, H. and Lonnerdal, B. Lack of association between alkaline phosphatase activity and pyridoxal 5'-phosphate or total vitamin B-6 concentrations in human milk. Am. J. Clin. Nutr. 53:P-27, 1991.

Sabban, E. L., Failla, M.L., McMahaon, A and Seidel, K.E. Dietary copper can regulate the level of mRNA for dopamine B-hydroxylase in rat adrenal gland. FASEB J. 5:1453.

Salbe, A.D., Albanes, D., Winick, M., Taylor, P.R. and Levander, O.A. Effect of elevated selenium intakes on mammary cell proliferation in rats. FASEB J. 5:A1444, 1991.

Seidel, K.E., Casdtonguay, T.W. and Failla, M.L. Copper deficiency increases levels of dopamine (DA) and norephinephrine (NE) in ventromedial hypothalamus without altering feeding patterns. FASEB J. 5:A584, 1991.

Sinha, R., Block, GG., Mangels, A.R., Levander, O.A., Patterson, B., Moorhead, M.M. and Taylor, P.R. Determinants of plasma ascorbic acid in healthy males. FASEB J. 5:A1444, 1991.

Smith, J.C., Micozzi, M.S., Brown, E.D., Edwards, B.K., Bieri, J.G., Taylor, P.R., Khachik, F. and Beecher, G.R. Plasma Carotenoids in Men Fed Beta-Carotene or Vegetables for Six Weeks. FASEB J. 5:A1073, 1991.

Udomkesmalee, E., S. Dhanamitta, S. Charoenkiatkul, S. Tantipopipat, O. Banjong, N. Rojroongwasinkul, T.R. Kramer and J.C. Smith, Jr. Effect of supplementation on vitamin A and zinc nutriture of children in northeast (NE) Thailand. FASEB J. 5:A718, 1991.

Udomkesmalee, E., S. Dhanamitta, S. Charoenkiatkul, S. Tantipopipat, O. Banjong, N. Rojroongwasinkul, T.R. Kramer and J.C. Smith, Jr. Effect of supplementation on vitamin A and zinc nutriture of children in northeast (NE) Thailand. XIV Int. Vit A Consult. Gr (IVACG), Guayaquil, Ecuador, p. 83, June 1991.